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THE VITAMIN CONTENT OF PHILIPPINE FOODS, II

VITAMIN C IN VARIOUS FRUITS AND VEGETABLES

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Of the Bureau of Science, Manila

ONE PLATE AND SIXTEEN TEXT FIGURES

Investigations of vitamins have shown that the lack of vitamin C in the diet leads to the development of scurvy. Aside from its antiscorbutic property vitamin C plays an important rôle in the process of normal metabolism. Scurvy affects the nutritional condition and the normal function of some important tissues of the body. The object of the work here reported was to determine the vitamin C content of the commonest Philippine fruits and vegetables. Filipinos depend mostly on native fruits and vegetables for their vitamin C supply.

Embrey(1) tested a few samples of Chinese and Philippine fruits and vegetables for their vitamin C content. Some of them gave very satisfactory results.

Perry and Silva(2) experimented on three varieties of mango grown in India. According to their results, "Alphonso" variety is one of the most potent natural sources of vitamin C; "Cawasji Patel" is slightly less active, and the "Shendrya" variety is rather poor in vitamin C.

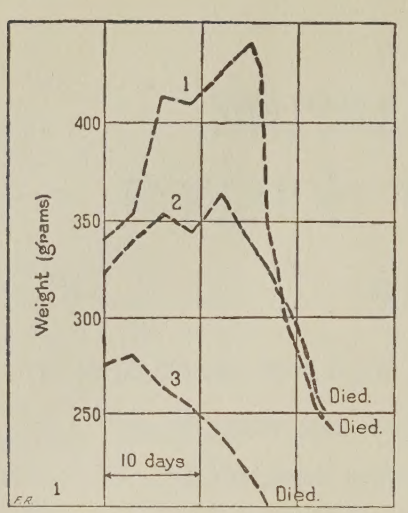
MATERIALS AND EXPERIMENTAL PROCEDURE

The materials used in this investigation were purchased in the public markets of Manila. They consisted of fifteen kinds of fruits and leafy vegetables as follows:

Fruits:

Mango (carabao and pico varieties); *Mangifera indica* Linn.

Lansones; *Lansium domesticum* Correa.



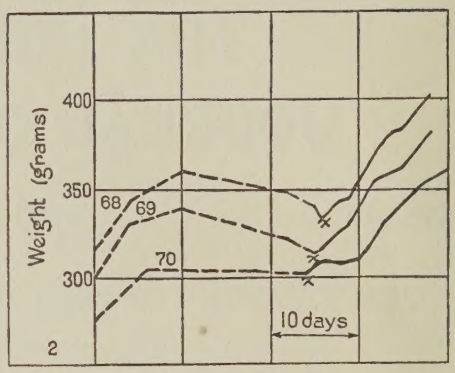


FIG. 1. Guinea pigs 1, 2, and 3 were fed with the basal diet. They all died after seventeen to twenty-four days of feeding.

FIG. 2. Guinea pigs 68, 69, and 70 were fed with the basal diet until scurvy was produced. From the point X each animal received daily 10 cubic centimeters of atis in addition to the basal diet. All were cured of scurvy. Atis is a good source of vitamin C.

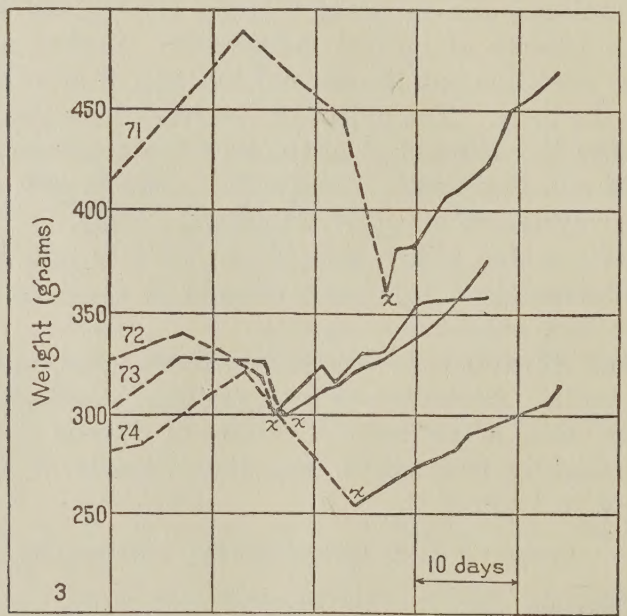
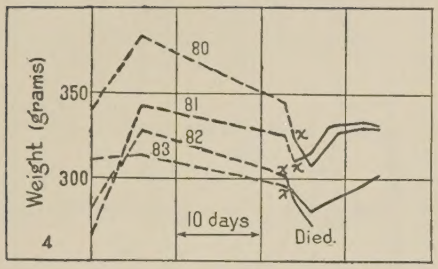


FIG. 3. Guinea pigs 71, 72, 73, and 74 were fed with the basal diet until scurvy was produced. From the point X each animal received daily 8 cubic centimeters of guayabano in addition to the basal diet. All were cured of scurvy. Guayabano is an excellent source of vitamin C.



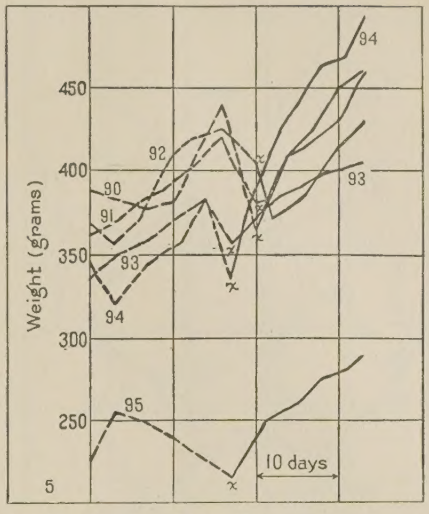


FIG. 4. Guinea pigs 80, 81, 82, and 83 were fed with the basal diet until scurvy was produced. From the point X each animal received daily 10 cubic centimeters of lansones in addition to the basal diet. Three guinea pigs recovered very slowly and one died. Lansones contain vitamin C.

FIG. 5. Guinea pigs 90, 91, 92, 93, 94, and 95 were fed with the basal diet until scurvy was produced. From the point X guinea pigs 90, 91, 92, and 95 each received daily 6 cubic centimeters of mango, carabao variety, in addition to the basal diet. No. 93 received daily from the point X, 7 cubic centimeters of mango and No. 94 received 8 cubic centimeters. All were cured of scurvy. Carabao variety is an excellent source of vitamin C.

Fruits—Continued.
Guayabano; *Anona muricata* Linn.
Ates; *Anona squamosa* Linn.
Mandarin; *Citrus nobilis* Lour.
Leafy vegetables:
Alugbati; *Basella rubra* Linn.
Kankóng; *Ipomea reptans* Linn.
Pechay; *Brassica chinensis* Linn.
Saluyot; *Corchorus olitorius* Linn.
Lettuce; *Lactuca sativa* Linn.
Sili; *Capsicum frutescens* Linn.
Kolites; *Amaranthus viridis* Linn.
Mustard; *Brassica integrifolia* (West) O. E. Schulz.
Pakó; *Athyrium esculentum* Copel.

Table 1 gives the vitamin C content of these various fruits and leafy vegetables.

Sixty healthy guinea pigs were used in this investigation. They were fed ad libitum with a basal ration consisting of the following:

Material.	Per cent.
Rice	51
Rice bran	8
Skim-milk powder	30
Butter fat	10
Sodium chloride	1

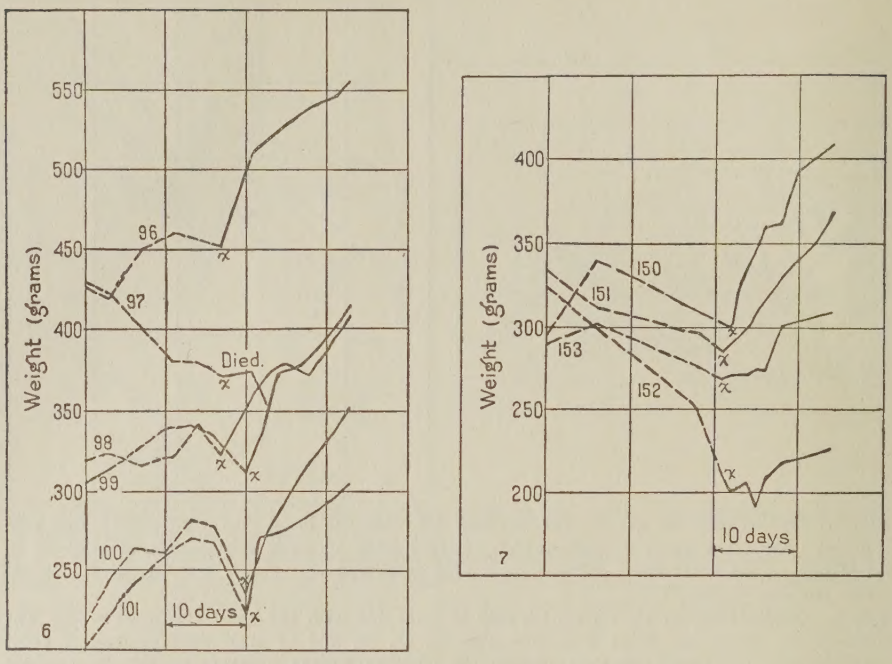
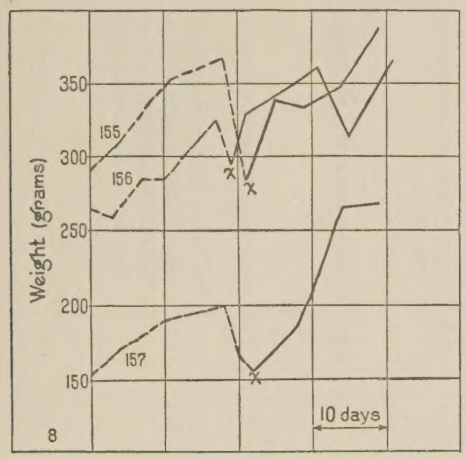


FIG. 6. Guinea pigs 96, 97, 98, 99, 100, and 101 were fed with the basal diet until scurvy was produced. From the point X, pigs 98, 99, 100, and 101 each received daily 7 cubic centimeters of mango, pico variety, in addition to the basal diet. No. 96 received 8 cubic centimeters of mango; No. 97 received 6 cubic centimeters and died. Pico mango is an excellent source of vitamin C.

FIG. 7. Guinea pigs 150, 151, 152, and 153 were fed with the basal diet until scurvy was produced. From the point X each guinea pig received daily 5 cubic centimeters of mandarin orange in addition to the basal diet. Nos. 150 and 151 responded promptly to the treatment, and Nos. 152 and 153 were slow. Mandarin orange is an excellent source of vitamin C.

The rice was boiled, dried at 110° C. for three hours, and then powdered. The skim-milk powder was previously heated at 110° C. for three hours. In addition to the basal ration, the animals were given hay previously heated at 110° C. for three hours and sufficient artesian well water. The guinea pigs were fed with this diet until the symptoms of scurvy were produced.

We found that most of our experimental animals would not eat sliced fruits. Consequently the pulp was cut into small pieces and ground thoroughly in a porcelain mortar. It was then squeezed through cheesecloth to make a homogeneous mixture of juice and pulp. The mixture was given daily to each guinea pig by means of a pipette placed in the mouth. Weighed quantities of the fresh leafy vegetables were given to each guinea pig in amounts shown in Table 1 and in text figures 8 to 16.



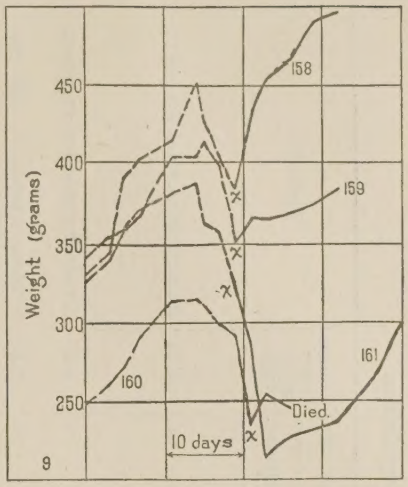
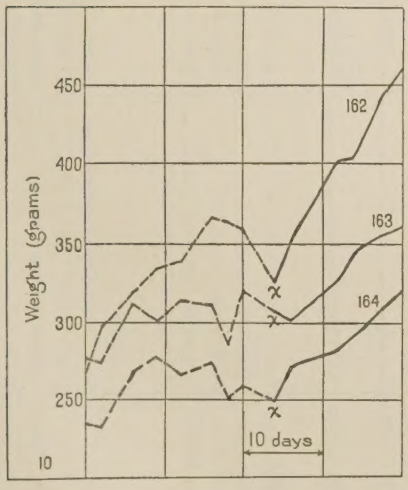


FIG. 8. Guinea pigs 155, 156, and 157 were fed with the basal diet until scurvy was produced. From the point X each guinea pig received daily 10 grams of alugbati in addition to the basal diet. Alugbati was found to be an excellent source of vitamin C.

FIG. 9. Guinea pigs 158, 159, 160, and 161 were fed with the basal diet until scurvy was produced. From the point X each guinea pig received daily 10 grams of sili leaves and tender shoots in addition to the basal diet. Guinea pigs 158 and 161 showed quick recovery, No. 159 was slow, and No. 160 died. Chile leaves were found to contain vitamin C.



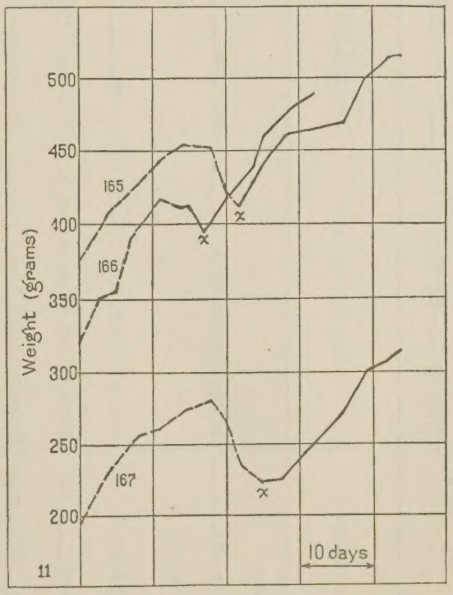


FIG. 10. Guinea pigs 162, 163, and 164 were fed with the basal diet until scurvy was produced. From the point X each guinea pig received daily 10 grams of kankong leaves and tender shoots in addition to the basal diet. Kankong was found to be an excellent source of vitamin C.

FIG. 11. Guinea pigs 165, 166, and 167 were fed with the basal diet until scurvy was produced. From the point X each guinea pig received daily 10 grams of kolites leaves and tender shoots in addition to the basal diet. Kolites was found to be an excellent source of vitamin C.

TABLE 1.—*Experimental data of various fruits and vegetables.*

Serial No.	Common names.	Scientific name.	Natural family.	Used to supplement or cure.		Average daily gain in weight.	Remarks.
				Part of plant.	Amount.		
	FRUITS				*cc.*	*g.*	
1	Sugarapple, ates, atit	*Anona squamosa* Linn.	Anonaceæ	Strained pulp and juice of matured ripe fruits.	10	4.74	An excellent source of vitamin C.
2	Guayabano, guanabano, gabano.	*Anona muricata* Linn.	do.	do.	8	4.21	An excellent source of vitamin C.
3	Lanzon, lansones	*Lansium domesticum* Correa.	Meliaceæ	do.	*10	2.15	Contains vitamin C. One guinea pig died.
4	Mango, mangá, páho, mangang-carabao.	*Mangifera indica* Linn.	Anacardiaceæ	do.	6	4.98	A very potent natural source of vitamin C.
5	Mango, mangá, páho, mangang-pico.	do.	do.	do.	7	7.14	Do.
6	Naranjita, mandarin, sintones, darogis.	*Citrus nobilis* Lour.	Rutaceæ	do.	5	5.19	A very potent source of vitamin C.
	VEGETABLES				*g.*		
7	Alugbáti, libáto, grana, arogbáti.	*Basella rubra* Linn.	Basellaceæ	Leaves and tender shoots.	10	5.15	An excellent source of vitamin C.
8	Chile, sili, katumbal, kitikot, chileng-bundok.	*Capsicum frutescens* Linn.	Solanaceæ	do.	10	5.06	The leaves contain vitamin C. Two pigs responded immediately, one responded after four days treatment, and the other died.
9	Kankóng, tangkong, kangkong.	*Ipomea reptans* Linn.	Convolvolaceæ	do.	10	5.48	An excellent source of vitamin C.

10	Kolites, kulitis, kalunai, halom.	*Amaranthus viridis* Linn.	Amaranthaceæ	do	10	5.26	Do.
11	Lettuce, lechuga	*Lactuca sativa* Linn	Compositæ	Entire leaves	10	4.44	Do.
12	Mustard, mostaza	*Brassica integrifolia* (West) O. E. Schulz.	Cruciferæ	do	10	3.31	Contains no appreciable amount of vitamin C. Two guinea pigs did not recover.
13	Pako, pakó	*Athyrium esculentum* Copel	Polypodiaceæ	Tender leaves	10	0.00	Contains an insufficient amount of vitamin C.
14	Pechay, pechai, messay, selgas.	*Brassica chinensis* Linn	Cruciferæ	Entire leaves	10	6.05	An excellent source of vitamin C.
15	Saluyot, tagabang, pasau, pasau-na-haba.	*Corchorus olitorius* Linn	Tiliaceæ	Leaves and tender shoots.	10	4.09	Do.

[a] Or 11 g.

An autopsy was made on each guinea pig that died during the experiments. All guinea pigs illustrated on Plate 1 had characteristic symptoms of scurvy showing this to be the cause of their death.

Results of our vitamin C experiment are given in Table 1. The text figures (1 to 16) demonstrate the biological tests on the guinea pigs.

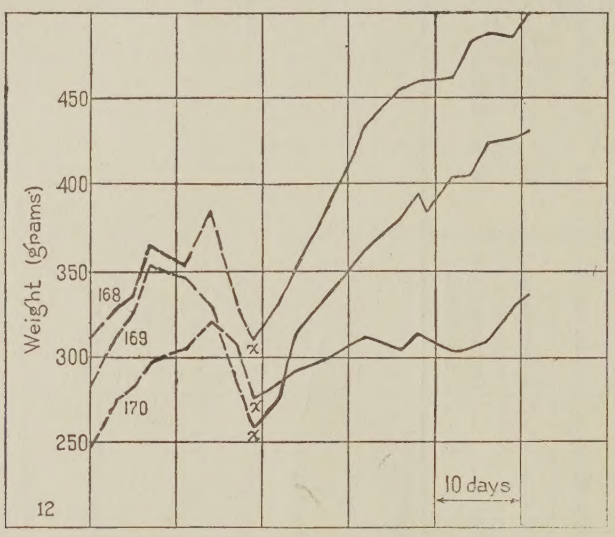
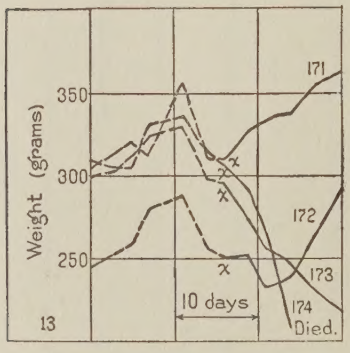


FIG. 12. Guinea pigs 168, 169, and 170 were fed with the basal ration until scurvy was produced. From the point X each guinea pig received daily 10 grams of lettuce leaves in addition to the basal diet. Lettuce was found to be an excellent source of vitamin C.



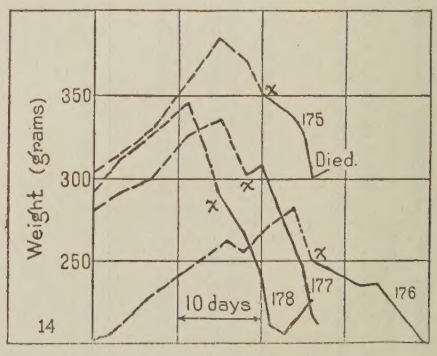


FIG. 13. Guinea pigs 171, 172, 173, and 174 were fed with the basal diet until scurvy was produced. From the point X each guinea pig received daily 10 grams of mustard leaves in addition to the basal diet. Mustard leaves do not contain an appreciable amount of vitamin C.

FIG. 14. Guinea pigs 175, 176, 177, and 178 were fed with the basal diet until scurvy was produced. From the point X each guinea pig received daily 10 grams of pakó leaves in addition to the basal diet. Pakó was found to contain an insufficient amount of vitamin C.

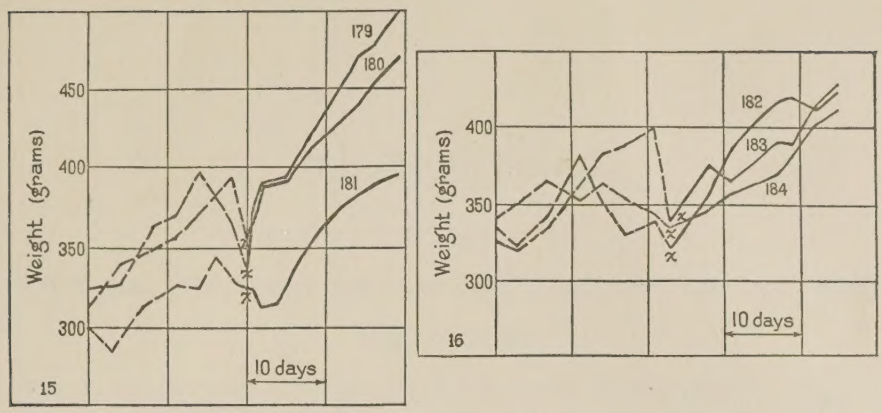


FIG. 15. Guinea pigs 179, 180, and 181 were fed with the basal diet until scurvy was produced. From the point X each guinea pig received daily 10 grams of pechay leaves in addition to the basal diet. Pechay was found to be an excellent source of vitamin C since all the guinea pigs were cured of scurvy.

FIG. 16. Guinea pigs 182, 183, and 184 were fed with the basal diet until scurvy was produced. From the point X each guinea pig received daily 10 grams of saluyot leaves and tender shoots in addition to the basal diet. Saluyot was found to be an excellent source of vitamin C.

SUMMARY

As a result of our experiments it would seem that Philippine fruits and vegetables vary considerably in their vitamin C content.

Mangoes (carabao and pico varieties) and mandarin are potent natural sources of vitamin C. Guayabano and ates are also excellent sources of vitamin C; lansones are rather deficient.

Alugbati, kankóng, kolites, lettuce, saluyot, and pechay are excellent sources of vitamin C, and sili leaves contain a fair amount of vitamin C. Mustard has less vitamin C than sili but more than pako, which has an insufficient amount.

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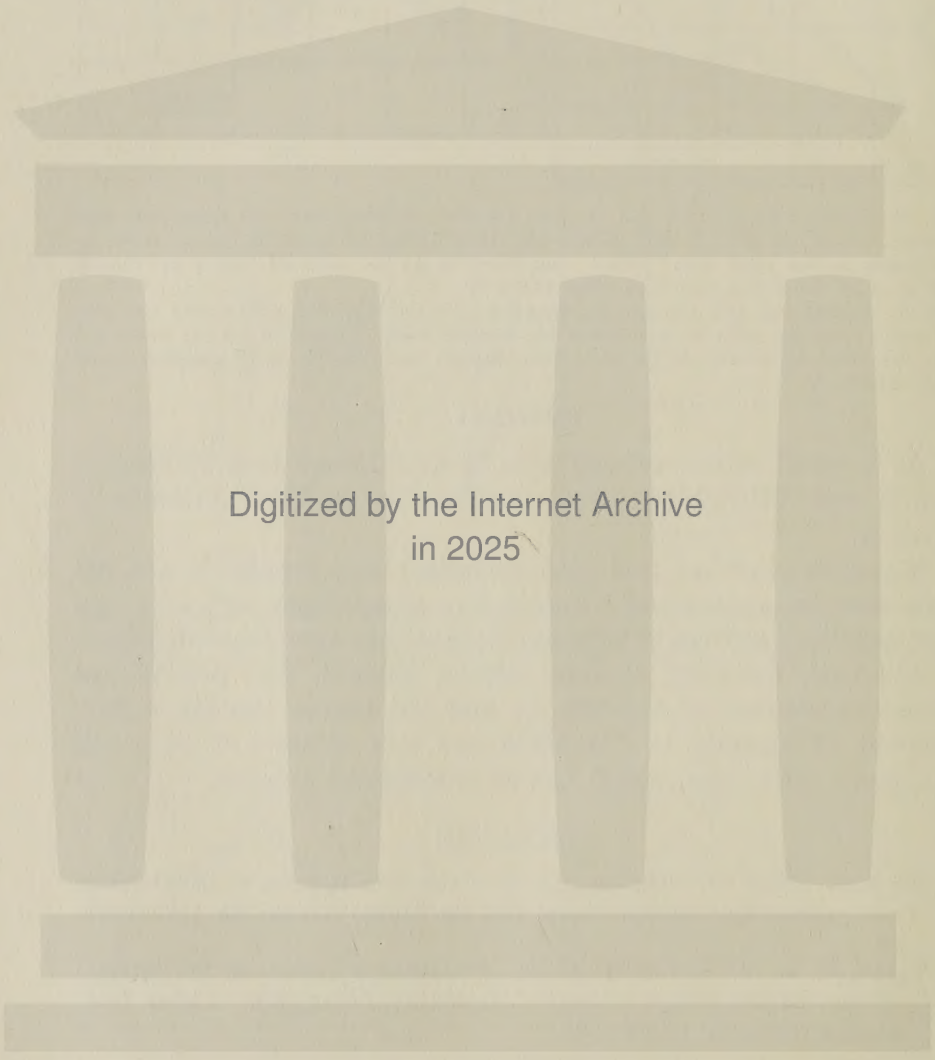
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ILLUSTRATIONS

PLATE 1

Guinea pigs with swollen jaws and lack of vigor are sick with scurvy.

TEXT FIGURES

FIG. 1. Guinea pigs 1, 2, and 3 were fed with the basal diet. They all died after seventeen to twenty-four days of feeding.

2. Guinea pigs 68, 69, and 70 were fed with the basal diet until scurvy was produced. From the point X each animal received daily 10 cubic centimeters of atis in addition to the basal diet. All were cured of scurvy. Atis is an excellent source of vitamin C.

3. Guinea pigs 71, 72, 73, and 74 were fed with the basal diet until scurvy was produced. From the point X each animal received daily 8 cubic centimeters of guayabano in addition to the basal diet. All were cured of scurvy. Guayabano is an excellent source of vitamin C.

4. Guinea pigs 80, 81, 82, and 83 were fed with the basal diet until scurvy was produced. From the point X each animal received daily 10 cubic centimeters of lansones in addition to the basal diet. Three guinea pigs recovered very slowly and one died. Lansones contain vitamin C.

5. Guinea pigs 90, 91, 92, 93, 94, and 95 were fed with the basal diet until scurvy was produced. From the point X guinea pigs 90, 91, 92, and 95 each received daily 6 cubic centimeters of mango, carabao variety, in addition to the basal diet. No. 93 received daily from the point X, 7 cubic centimeters of mango and No. 94 received 8 cubic centimeters. All were cured of scurvy. Carabao mango is an excellent source of vitamin C.

6. Guinea pigs 96, 97, 98, 99, 100, and 101 were fed with the basal diet until scurvy was produced. From the point X guinea pigs 98, 99, 100, and 101 each received daily 7 cubic centimeters of mango, pico variety, in addition to the basal diet. No. 96 received 8 cubic centimeters of mango; No. 97 received 6 cubic centimeters and died. Pico mango is an excellent source of vitamin C.

7. Guinea pigs 150, 151, 152, and 153 were fed with the basal diet until scurvy was produced. From the point X each guinea pig received daily 5 cubic centimeters of mandarin orange juice in addition to the basal diet. Nos. 150 and 151 responded promptly to the treatment, and Nos. 152 and 153 were slow. Mandarin orange is an excellent source of vitamin C.

FIG. 8. Guinea pigs 155, 156, and 157 were fed with the basal diet until scurvy was produced. From the point X each guinea pig received daily 10 grams of alugbati in addition to the basal diet. Alugbati was found to be an excellent source of vitamin C.

9. Guinea pigs 158, 159, 160, and 161 were fed with the basal diet until scurvy was produced. From the point X each guinea pig received daily 10 grams of sili leaves and tender shoots in addition to the basal diet. Guinea pigs 158 and 161 showed quick recovery, No. 159 was slow, and No. 160 died. Chile leaves were found to contain vitamin C.
10. Guinea pigs 162, 163, and 164 were fed with the basal diet until scurvy was produced. From the point X each guinea pig received daily 10 grams of kankong leaves and tender shoots in addition to the basal diet. Kankong was found to be an excellent source of vitamin C.
11. Guinea pigs 165, 166, and 167 were fed with the basal diet until scurvy was produced. From the point X each guinea pig received daily 10 grams of kolites leaves and tender shoots in addition to the basal diet. Kolites was found to be an excellent source of vitamin C.
12. Guinea pigs 168, 169, and 170 were fed with the basal ration until scurvy was produced. From the point X each guinea pig received daily 10 grams of lettuce leaves in addition to the basal diet. Lettuce was found to be an excellent source of vitamin C.
13. Guinea pigs 171, 172, 173, and 174 were fed with the basal diet until scurvy was produced. From the point X each guinea pig received daily 10 grams of mustard leaves in addition to the basal diet. Mustard leaves do not contain an appreciable amount of vitamin C.
14. Guinea pigs 175, 176, 177, and 178 were fed with the basal diet until scurvy was produced. From the point X each guinea pig received daily 10 grams of pakó leaves in addition to the basal diet. Pakó was found to contain an insufficient amount of vitamin C.
15. Guinea pigs 179, 180, and 181 were fed with the basal diet until scurvy was produced. From the point X each guinea pig received daily 10 grams of pechay leaves in addition to the basal diet. Pechay was found to be an excellent source of vitamin C since all the guinea pigs were cured of scurvy.
16. Guinea pigs 182, 183, and 184 were fed with the basal diet until scurvy was produced. From the point X each guinea pig received daily 10 grams of saluyot leaves and tender shoots in addition to the basal diet. Saluyot was found to be an excellent source of vitamin C.

PLATE 1.

A SECOND RECORD OF A SOLENOSTOMID FROM THE PHILIPPINES [1]

By José R. Montilla

Of the Fish and Game Administration, Manila

In June, 1932, while collecting living material for the Manila Aquarium, at Calapan, Mindoro, the writer obtained the following described specimen. It was taken in a "pukot," or fine-meshed native seine, along with pipefishes, rock-pilots, and other small species among the eelgrass in water about 1.5 meters in depth. It was received alive but survived only a short time. Because of its rarity it is herewith recorded.

SOLENOSTOMIDÆ

Snout produced into a long tube. Body compressed, tail very short with long broad caudal fin. All parts covered with thin skin, below which is the dermal skeleton formed by large star-like ossifications. Mouth small, terminal. Spinous dorsal short; soft dorsal long and opposite to anal. Soft dorsal and anal fins on elevated bases; caudal fin long. Ventrals abdominal, and opposite the spinous dorsal, each of seven rays. They are free in the male, but the inner sides coalesce with the integument of the body to form a large pouch for the reception of the eggs in the female. Operculum well developed. Gill opening wide.

SOLENOSTOMUS PHANTASTICUS Herre.

Solenostomus phantasticus Herre, Copeia (April 3, 1933) 17.

Dorsal V, 17; anal 18; pectoral 26; ventral 7; depth $4\frac{1}{2}$ in length; head $2\frac{1}{2}$; eye $7\frac{2}{3}$ in head and $5\frac{2}{3}$ in snout; least height of snout about three times the length of the body. A blunt spine just in front of each eye, and two spines at the cristæ. Five spines, generally not well developed, on each side of the interorbital space. Opercle with distinct radiating ridges and armed with three spines. All tubercles developed into

[1] Contribution No. 3 from the Fish and Game Administration, Department of Agriculture and Commerce.

short, blunt spines. First ring around the body with nine spines. Second with ten spines and the third with fourteen. Twenty-six body rings present from just below first dorsal to caudal, each body ring with six spines. Second dorsal and anal fins elevated and each with four, short, blunt spines.

First dorsal rises from an elevated base; the length of the first dorsal base is 4 millimeters; that of second dorsal, 6, and of the anal, 6.

First dorsal spines 4 in length. Caudal peduncle comparatively slender; the least depth twice in its length. Height of caudal peduncle a little more than 2 in base of second dorsal. Dorsal and anal unbranched, and, like caudal and pectoral, extensive, rounded but short. Ventrals opposite spinous dorsal, very large with seven bifurcate rays. Skin provided with scattered, more or less visible, dermal prolongations, or villi which are branched in some places.

Color in life brown, with irregular, oblong, orange spots, each with a paler center. One series of these forms an irregular marking from eye to caudal. Spinous dorsal with large black blotches on membrane between first three spines. Other black blotches on first dorsal spines small; soft dorsal and anal mottled; caudal clouded with blackish.

The brown and black color remained unchanged in alcohol, but the irregular oblong spots of orange, each with a paler center, became white.

The above description is based on one specimen, a female, Fish and Game Administration No. 41044, 93 millimeters in total length, collected at Calapan, Mindoro, June 16, 1932.

Although members of the family Solenostomidæ have been previously recorded from Zanzibar, Mauritius, Maldives, Gulf of Manaar, Japan, Hawaii, and Ceram, this is the second record of this family and species in the Philippines.

This specimen agrees in most respects with *Solenostomus phantasticus* Herre; it differs chiefly in the depth of the body and in the natural coloring. The color of Herre's specimen was light red with many short stripes and cabalistic marking of deep maroon. Herre described the species from a single specimen, also female, 72 millimeters long, obtained in eelgrass at Dumaguete, Oriental Negros, Philippine Islands.

OBSERVATIONS ON THE PHILIPPINE WEAVER, MUNIA JAGORI MARTENS, II: FOODS AND FEEDING HABITS [1]

By CANUTO G. MANUEL

Of the Fish and Game Administration, Manila

ONE TEXT FIGURE

INTRODUCTION

The first paper of this series (1930) dealt with the breeding and associational habits of the Philippine weaver; the present one presents the food and feeding habits of the young and adult birds. These studies are necessary in order to determine the economic relation of this species of bird to agriculture and to enable us to furnish data for more adequate legislation on conservation.

The period of study may be divided into two parts, the materials studied in Los Baños between 1926 and 1928, and later observations extending to other places from June to November, 1932. Suspension of the studies between 1928 and 1932 was due to the writer's absence abroad.

METHODS OF STUDY

Three methods of study were involved; namely, laboratory stomach examinations, field observations, and experiments with newly caged birds.

Up to 1928 the examinations of stomachs were made in the Department of Entomology, College of Agriculture, at Los Baños, while later laboratory studies were made in the division of zoölogy of the Bureau of Science, Manila. The materials studied up to 1928 were collected around Los Baños, particularly on the grounds of the College of Agriculture. Later collecting

[1] Contribution No. 4 from the Fish and Game Administration, Department of Agriculture and Commerce. The writer is under obligation to Dr. Leopoldo B. Uichanco, of the College of Agriculture, University of the Philippines, for suggesting this study; and to Dr. José B. Juliano, of the College of Agriculture, and to Mr. Edilberto Karganilla, of the Bureau of Science, for the identification of weeds.

was extended to Rizal, Laguna, Tayabas, Batangas, Cavite, Bulacan, Pampanga, Tarlac, and Nueva Ecija Provinces. Diverse types of ecological relations, open fields, both far from and near fresh and salt water, slopes, and valleys exist in the various localities covered by this study. All have representative samples. The birds were collected from rice fields as well as in places far from rice fields. From the rice fields they were obtained at different stages of the plant and before and after the rice season.

Examinations of the fæces of the birds were made in an attempt to determine whether or not the seeds pass through the system uninjured. In order to determine whether the seeds excreted were viable or not, the fæcal materials were sown in a seed box provided with sterilized soil.

To determine the maximum degree of the damage done by these birds to the rice crop, newly caged birds were fed with rice seeds in a Petri dish. The number of seeds given and the number left after feeding were recorded.

In order to determine whether the birds have any preference for a particular kind of food, seeds of rice of different stages of maturity, and of several varieties of weeds were offered at the same time to the caged birds. The seeds were given in panicles and placed in different places in the cage.

Studies dealing with the food of the young were superficial. In order to avoid killing the nestlings, samples were taken by slightly pressing the crop, and the kind and number of seeds noted.

The food materials recovered from the oral opening and from the gizzard of the adult birds were recorded and considered in the estimates. This portion of the digestive system is referred to as the stomach, for the food is generally recovered in the crop, proventriculus, and gizzard.

Both the "percentage by bulk"(4) and the "numerical"(4) systems of determining the amount of food were employed in this study. In the studies from 1926 to 1928 the "percentage by bulk system" was used; that is, the volume of each food item (rice seeds and the seeds of different varieties of weeds) was considered; in the later procedure the number of seeds of each food item recovered was noted.

Percentages are expressed in integers; fractions of less than one-half are considered as nil.

The significance of the results is expressed in the relation both of the individual bird and of the species as a whole to their food, and vice versa. The relation of the bird to the food is indicated by the average of the percentages of the different foods recovered in its stomach. The relation of the food to the bird is expressed in the percentage of the birds in a given lot and of all the birds studied that feed on certain foods.

Determination of the weed seeds recovered from the stomach was made principally by comparing them with the materials that were collected and preserved for this purpose. In the determination of the species of weed seeds, no high degree of accuracy is claimed; however, the rice seeds were carefully segregated from those of the uncultivated plants. Usually weed seeds were collected in places where the birds were feeding.

RESULTS AND DISCUSSION

Much time was devoted to the examination of stomachs of adult birds. However, other means of studying the economic relation of the species were used.

FOOD OF ADULTS

As the food of adult birds, to a large degree, determines the relation of this species to the rice crop, adult individuals were used in most of the laboratory observations reported in this paper.

Stomach examination.—Stomach examinations were recorded by month and place of collection. Estimates of the value of the bird (kind and amount of each food item and number of birds feeding on each) were made of each locality by month. Deviations from 100 per cent of the birds feeding on rice and weeds were due to the combination of these food items in a single stomach.

Studies dealing with the food habits of the weaver birds were started in December, 1926, when twelve birds were collected near a rice field at the experiment station of the College of Agriculture. It was estimated that about 29 and 71 per cent of the contents of their stomachs were rice and weed seeds, respectively. Sabung-sabuñgan [2] comprises the greater part of the food mak-

[2] A list of the common and scientific names of the plants the seeds of which were recovered in the stomachs of birds is given on page 417.

ing about 53 per cent by bulk. Laau-laau and tiribuhan were also recovered to the extent of 9 and 7 per cent, respectively. The balance of about 2 per cent was due to the presence in one stomach of amor seco. One stomach was empty. Rice seeds were obtained from three birds, weed seeds from eight.

In January, 1927, fourteen birds were obtained at the experiment station mentioned. At the time of collecting, the rice was being harvested and the birds were obtained in the field where they came at occasional intervals to feed on panicles of rice. Examination of the stomachs of this lot showed that, by volume, rice comprised about 80 per cent of the food, while about 20 per cent consisted of weeds, tiribuhan, and sabung-sabuñgan, representing about 15 and 5 per cent, respectively. Rice was recovered from thirteen stomachs, and weeds from eight.

Harvesting of lowland rice in the College Experiment Station continued until about the end of March, 1927, when the three birds in this lot were collected. The birds still show preference for rice over weed seeds, stomach examination showing about 87 per cent of the former grain and about 13 per cent of the latter. The weeds were tiribuhan and laau-laau. The seeds of both rice and weeds were found in all stomachs.

Collections were made during April, 1928, in a ratooned sugarcane field of the College of Agriculture and in a rice field at Bay, both in Laguna Province, and in a rice field on the shore of Laguna de Bay at Angono, Rizal Province. Birds obtained from those three places were, fourteen from the grounds of the College of Agriculture, fifty from Bay, and sixteen from Angono. It was found that 58 per cent of the contents of the stomachs from the Agricultural College was rice, weeds making up the balance of 42 per cent. One stomach was empty, rice seeds were noted in ten stomachs, and weeds were obtained from six.

Examination of fifty stomachs collected at Bay resulted in the recovery of 84 per cent rice seeds and 16 per cent weed seeds from forty-nine of them; one stomach was empty. The bulk of weed seeds was tiribuhan, which constituted about 15 per cent. Seeds of sabung-sabuñgan, laau-laau and amor seco were also recovered. About 92 per cent of the birds collected fed on rice, as this grain was found in forty-six stomachs. Weed seeds were found in twenty-five stomachs representing 50 per cent of the birds in this lot.

One of the stomachs collected at Angono was empty. In those that contained food, rice and weed seeds constituted 98 and 2 per cent, respectively. Rice seeds were obtained from fifteen of sixteen birds, and tiribuhan was found in only two stomachs. About 94 per cent of the birds in this group had fed on rice, while about 13 per cent ate tiribuhan in addition.

Records from the three places named above indicate that the stomachs of seventy-seven birds collected in April, 1928, contained 79 per cent rice seeds and 21 per cent weed seeds, by volume. Rice seeds were recovered from seventy-one birds, representing about 89 per cent of the lot; weed seeds were obtained from thirty-three stomachs, representing about 41 per cent.

In May, 1928, twenty-two birds were obtained from the uncultivated grounds of the Agricultural College at Los Baños, Laguna Province. One stomach was empty. Of those with food, rice seeds constituted about 5 per cent of the contents while weed seeds represented slightly over 95 per cent. Of the weed seeds taken in this lot sabung-sabuñgan represented 70 per cent and tiribuhan 16 per cent. The remainder were seeds of luya-luyahan and laau-laau. Rice was recorded from three stomachs, or about 14 per cent of the birds collected. Weeds were recorded from twenty-one stomachs, or about 95 per cent of the birds.

The stomach contents of weavers collected at the Agricultural College Experiment Station, Los Baños, in June, 1928, largely consisted of weed seeds. From this place twelve birds were obtained at three different periods during the month. Volumetrically about 8 per cent of their food was rice seeds, and about 92 per cent was weed seeds. Of the weeds, sabung-sabuñgan comprised about 54 per cent, tiribuhan about 32 per cent, and luya luyahan and laau-laau combined about 5 per cent. Rice seeds were recorded from one stomach and weed seeds from all the stomachs. The volumetric method of determining the contents of the stomachs of one hundred thirty-one weavers, collected mostly around the College of Agriculture (Table 1) within a period of six months in three years, indicates that the birds are entirely grain-eating, rice representing 48 per cent, of their food and five species of weeds the balance of 52 per cent. Rice seeds were recorded from ninety-five of one hundred forty-three stomachs, showing that 66 per cent of the birds studied had fed on this grain.

TABLE 1.—*Value of Philippine weavers based on volumetric study of their foods.*

Locality and condition.	Collecting spot.	Date.	Birds collected.	Percentage composition of food (volume).		Percentage of birds feeding.	
				Rice.	Weeds.	Rice.	Weeds.
Laguna, Agricultural College: Diversified crops in practice.	Rice field in head.	Dec., 1926	12	29	71	25	66
Do	Harvested rice field.	Jan., 1927	14	80	20	93	57
Do	do	Mar., 1927	3	87	13	100	100
Agricultural College: Near buildings and small lots of sugar cane.	Ratooned sugar-cane field.	Apr., 1928	14	58	42	71	43
Bay: Rice fields	Rice field in head.	Apr., 1928	50	84	16	92	50
Rizal, Angono: Rice fields close to shore of Laguna de Bay.	do	Apr., 1928	16	98	2	94	13
Laguna, Agriculture College: Near campus. Fruit trees around.	Citrus orchard	May, 1928	22	5	95	14	95
Agricultural College: Diversified crops in practice.	Harvested rice field.	June, 1928	12	8	92	8	100

Weed seeds were taken from eighty-five stomachs. This is equivalent to 59 per cent of the birds feeding on this item. The results up to 1928 indicated that the bird was graminivorous, feeding on either rice seeds or weed seeds. The volume of the seeds remains proportionately constant to the number of seeds recovered. It was, therefore, thought best to change from the percentage by bulk to the numerical system. The actual number and the corresponding approximate volume were thus both indicated. An advantage of the numerical system is that by means of it can be recorded the presence of seeds too minute for accurate determination of their volume.

Actual collection of materials for stomach examination was resumed in July, 1932. Sixty stomachs, obtained from seven places in four provinces, were studied during that month. Ten stomachs were empty.

Ten birds were obtained in a rolling, open field at San Jose del Monte, Bulacan Province. One stomach was empty; nine contained weed seeds with a preponderance of sabung-sabuñgan. Numerically this weed composed about 6 per cent of the food taken from the stomachs of weavers in this lot. Batad-batádan and laau-laau constituted 16 and 17 per cent, respectively. Tiri-

buhan formed about 7 per cent, while three seeds of amor seco represented an insignificant percentage of the food recovered from this lot.

Seven birds were collected from Novaliches, Rizal Province, in two periods during the month. Examination of their stomachs indicated that they had fed wholly on weeds, amor seco occupying about 42 per cent numerically. Other weeds recovered were laau-laau sabung-sabuñgan, and batad-batádan.

In Tanay, Rizal, twenty-five birds were collected from one spot at one time. Nothing was recovered from nine of them. Of the recovered food, weed seeds formed about 96 per cent numerically. Sabung-sabuñgan was the heaviest item, representing about 80 per cent. Tiribuhan represented about 14 per cent. Laau-laau was the other weed obtained. Rice seeds comprised about 4 per cent of the food. The data show that 28 per cent of the birds collected in Tanay took rice seeds, and 40 per cent weed seeds.

Stomach contents of fourteen weavers collected in an open, rolling field newly planted to rice at Maketipo, Rizal Province, consisted entirely of weed seeds. Except in one stomach where six seeds of sabung-sabuñgan were obtained, laau-laau and amor seco either alone or in combination were found in all the stomachs examined.

The stomachs of two birds collected at Tungkong Manga, Bulacan Province, one from Los Baños, Laguna Province, and another from Amadeo, Cavite Province, contained weed seeds.

Fifty birds from seven places in four provinces yielded 33 rice seeds and 5,879 weed seeds distributed as follows: tiribuhan, 272; sabung-sabuñgan, 2,146; laau-laau, 2,399; amor seco, 757; and batad-batádan, 305. Numerically, the rice seeds comprised slightly less than 1 per cent. Rice seeds reported for this month were obtained from seven of twenty-five stomachs collected near a newly harvested rice field in Tanay, Rizal Province. The data indicate that about 12 per cent of the birds collected had fed on rice seeds and about 73 on weed seeds.

During August, 1932, Philippine weavers were collected in eleven places in three provinces.

The first group was obtained in Biñan, Laguna Province. In three places in this municipality forty-six birds were collected either in the rice field when the rice was ripe, close to the field, or about 5 kilometers from it.

Of thirteen stomachs collected far from the rice field one was empty and the food of twelve birds was largely weed seeds, only

two rice seeds having been secured from one stomach. Tiribuhan and laau-laau were the principal food items. In one stomach 704 seeds of tiribuhan were noted, while 588 seeds of laau-laau were taken from another. Sabung-sabuñgan and amor seco were recorded to a less extent.

Collecting in the rice field yielded results of a different nature. Of the thirteen stomachs examined, one was empty. A total of 392 rice seeds obtained from eleven stomachs comprised 24 per cent. Laau-laau, daua-dauahan, and amor seco were recovered from seven stomachs.

The data obtained from the birds collected near a rice field made the results from two other places named above more interesting. Two of the twenty stomachs collected from this place were empty. Rice seeds taken from ten stomachs comprised about 6 per cent. Three stomachs had nothing but rice seeds. A mixture of rice and weed seeds was noted in seven of them. Amor seco was the principal food item. Other weeds were tiribuhan, laau-laau, daua-dauahan, luya-luyahan, and sabung-sabuñgan. Weed seeds were noted in fifteen stomachs of this lot.

Numerically, rice and weed seeds comprised about 9 and 91 per cent, respectively, in this lot. Birds collected from the rice field tend to feed more on rice, while weeds constitute almost the entire food of those obtained away from a rice field; those secured near a rice field take both rice and weed seeds in amounts proportionate to the distance from the corresponding sources of food. Records from these three places of varying conditions show that twenty-two individuals, or about 48 per cent of the birds, collected in Biñan had taken rice seeds, while thirty-four individuals, or about 74 per cent, fed on weeds.

From a vacant rice field near Los Baños, Laguna Province, forty-two weavers, mostly young of the year, were obtained. The place of collection was about 300 meters from the nearest rice field where rice was in head. The birds, obviously coming to drink, congregated in drying carabao wallows.

Weeds constituted the entire food of the birds in this lot, with tiribuhan making up about 91 per cent and amor seco about 8 per cent. Other weed seeds, representing less than 1 per cent, were laau-laau and daua-dauahan.

Ten birds from a vacant rice field in Pila, Laguna Province, fed largely on weed seeds, according to the findings from their stomachs. In one stomach were recorded 10 seeds of rice and 58 of sabung-sabuñgan. A total of 826 seeds of tiribuhan, constituting about 80 per cent of the food, was obtained. Luya-

luyahan was recorded in one stomach. Rice seeds comprised about 1 per cent of the food of the birds in this lot. From this group one individual, or 10 per cent of the birds, had rice seeds in the stomach. Weeds were recovered from all of them.

In Candelaria, Tayabas Province, thirty-seven weavers were obtained in a rice field where the crop was in head. Flocks of this bird visited the field early in the morning and late in the afternoon. One flock that alighted in a rice field contained approximately seven hundred birds. Thirty-six stomachs contained 1,425 rice seeds, either alone or in combination with weed seeds. Numerically, rice seeds constituted about 35 per cent of the food recovered. The seeds of daua-dauahan, 1,723 seeds from twenty-four stomachs, outnumbered those of all other weeds combined, and represented about 42 per cent of the birds' food. During observation in this place the panicles of this species of weed were noted to overgrow those of the rice and this condition probably accounts for this weed's seeds being more numerous than those of rice, although the birds were collected in an extensive rice field. About this weed Quisumbing(10) states, "Some farmers purposely allow such grass to grow side by side with rice, and it is said to drive the birds away, because of the long awns of the spikelets, and thus protect their rice fields from the attack of birds." The effects of this weed on the rice crop, as indicated by Quisumbing, appear to agree with the trend of results obtained in this study, in that it saves the grain from the attacks of weaver birds. His statement, however, presents an entirely different view in so far as the cause of protection of the crop is concerned. It seems likely that the bird's preference for the seeds of the weed was the cause of less damage to the cultivated crop. Other seeds recovered were laau-laau and amor seco to the extent of about 15 and 8 per cent, respectively. The results from this lot show that thirty-six birds, or about 97 per cent, of the group fed on rice, while weed seeds were recovered from twenty-nine individuals, or about 80 per cent.

From Mauban, Tayabas Province, about 5 kilometers from the shore of the Pacific Ocean, in a small valley newly planted to rice, sixteen weavers were collected. Except in one stomach where 1 rice seed was obtained with 24 seeds of batad-batádan and 540 of tiribuhan, all of the birds collected had fed on weed seeds. The rice formed an insignificant part of 2,627 seeds recovered from the stomachs of this lot. These results indicate

that only 6 per cent of the birds had taken rice seeds, while weed seeds were obtained from all the stomachs.

In a large rice field in Lucban, Tayabas Province, seventy-one birds were obtained in two days. Collecting was done in the morning and in the afternoon when the birds were noted to feed on rice grains. Three stomachs were empty.

Rice seeds to the number of 756 were recovered from forty-three stomachs, representing about 8 per cent of the food recorded. Weeds consisting of eight species comprised about 92 per cent of the food by number. As in the samples from Candelaria, daua-dauahan outnumbered the other species of weeds combined. This weed constituted about 62 per cent of the entire food obtained. Tiribuhan, amor seco, and sabung-sabuñgan constituted about 12, 7, and 6 per cent, respectively. Laau-laau, batad-batádan, *Cyperus* sp., and kabit-kabit represented the balance of 5 per cent.

About 61 per cent of the birds took rice seeds. Weeds were recovered from sixty-one stomachs, or about 86 per cent, of the birds in this lot.

Near an upland rice field in Balayan, Batangas Province, seven birds were collected August 25. In their stomach contents 64 rice seeds constituted about 20 per cent, 164 seeds of tiribuhan about 53 per cent, 81 seeds of amor seco 26 per cent, and 6 seeds of sabung-sabuñgan less than 1 per cent.

Five, about 71 per cent, of the birds of this lot had fed on rice seeds, while all devoured weeds belonging to either one or a combination of the three species named above.

While the grain was in head in a rice field near Lemery, Batangas Province, five weavers were shot in the act of feeding. Rice seeds constituted about 2 per cent, numerically, of the stomach contents. Daua-dauáhan made up the balance of about 98 per cent. Rice seeds were recovered from two of the birds, and daua-dauáhan from four.

In Tanauan, Batangas, twelve weavers were shot in an upland rice field when the grain was in head. Two stomachs were empty. From seven birds 118 rice seeds were obtained, representing about 23 per cent of the food recovered. With a preponderance of laau-laau, constituting about 46 per cent, four species of weeds were noted. The other species were tiribuhan, *Cyperus* sp., and amor seco, about 16, 10, and 5 per cent, respectively. Weed seeds were recovered from five stomachs. In this lot 58 per cent of the birds fed on rice seeds, while about 42 per cent ate weed seeds.

The food of the Philippine weaver in August, deduced from a study of 246 individuals collected in eleven places in three provinces, numerically, was 11 per cent rice seeds and 89 per cent weed seeds. About 48 per cent of these birds had fed on rice seeds, and about 85 per cent on weed seeds.

Studies in September, 1932, were confined to two days collecting in the neighborhood of Los Baños, Laguna, in a vacant rice field near fields where rice was in head.

Twenty-one birds were obtained in this lot. One stomach was empty. Rice seeds constituted about 1 per cent of the food. Weed seeds represented about 99 per cent. The largest item was 2,915 seeds of tiribuhan, about 78 per cent. Amor seco and batad-batádan constituted about 17 and 4 per cent, respectively.

Rice seeds were obtained from ten stomachs, or about 48 per cent; weed seeds from seventeen stomachs, or about 81 per cent of the birds.

Studies for October, 1932, were made in Bulacan, Pampanga, Nueva Ecija, and Tarlac Provinces, which are extensive rice-growing regions in the Central Plain of Luzon.

In Bulacan Province the birds were collected from the municipalities of Pulilan, Quiñgua, Baliuag, Bustos, San Rafael, and San Ildefonso.

In Pulilan twenty-one birds were obtained October 2 and 3 in an uncultivated place about 5 kilometers from the nearest rice field. One stomach was empty, and from the rest 14,357 seeds of weeds belonging to ten species were recorded. Amor seco was the largest item noted with 11,228 seeds. Other weeds obtained were daua-dauahan, sabun-sabuñgan, agiñgai, tiribuhan, laau-laau, katábad alitbañgun, *Cyperus* sp., and batad-batádan.

In an open field at Quiñgua, where there were various crops (sweet potato, corn, rice, etc.), forty-six weavers were collected October 5. That the rice was in the flowering stage perhaps explains the absence of this grain in the stomachs of the birds examined. A total of 25,782 seeds of weeds belonging to thirteen species were recorded. The largest of these items was 21,854 seeds of amor seco. Sabung-sabuñgan and daua-dauáhan were represented by 2,017 and 1,445 seeds, respectively. Other weeds noted were *Cyperus* sp., agiñgai, tiribuhan, laau-laau, katábad, bocaui, luya-luyáhan, *Phyllanthus simplex*, batad-batádan, and iba-ibá-an.

Collecting in Makinabang, Baliuag, at two different periods yielded twenty-seven stomachs. The place was far from any field of rice in head. This perhaps explains the recovery of only fourteen seeds of this grain in two stomachs, representing a negligible fraction of the 18,215 seeds recorded from this lot. Amor seco made up about 88 per cent and sabung-sabuñgan about 5 per cent. Other weeds recorded were daua-dauáhan, agiñgai, alitbañgun, *Cyperus* sp., batad-batádan, and laau-láau. All stomachs from this lot contained weed seeds, and about 7 per cent had rice seeds.

October 4 and 7 thirty-six birds were obtained in Baliuag, about 4 kilometers from a field of rice in head. The food recovered from twenty-seven of these birds was calculated to consist of about 6 per cent rice seeds and 94 per cent weed seeds. The other stomachs were empty. Representing about 66 per cent of the food noted were 1,821 seeds of amor seco. Other weed seeds taken were tiribuhan, sabung-sabuñgan, daua-dauáhan, luya-luyáhan, laau-láau, katábad, and *Cyperus* sp. Rice seeds were recorded from twelve stomachs, and weed seeds from twenty-four stomachs.

In the afternoon of October 15, in a rice field by the river at Bustos, eighteen birds were taken. The stomachs of eleven were empty. From four stomachs twelve rice seeds were recorded, comprising about 44 per cent of the food recovered. Sabung-sabuñgan and luya-luyáhan noted in four stomachs made up the balance of about 56 per cent.

At San Rafael twenty-eight birds were collected near a rice field with grain in head. One stomach was empty. Rice seeds recovered from twenty-three stomachs constituted about 16 per cent of the contents. Weed seeds recorded from twenty-three stomachs constituted about 84 per cent. The largest item in this lot was 509 seeds of sabung-sabuñgan, representing about 30 per cent of the food. In one stomach were 477 seeds of agiñgai, representing about 28 per cent of the entire food. Other seeds were katábad, amor seco, laau-láau, *Cyperus* sp., and tiribúhan.

Four weavers were collected from a field of rice not in head at San Ildefonso. One stomach was empty. From three stomachs were recovered 21 seeds of katábad, 17 of sabung-sabuñgan, and 3 of tiribúhan, respectively.

One hundred seventy-six weavers were obtained from seven places in Bulacan Province. Rice seeds constituted about 9 per cent of the food and weed seeds 91 per cent.

About 24 per cent of the birds (42 individuals) collected had fed on rice seeds and about 84 per cent of the lot (148 birds), on weed seeds.

In Pampanga Province five birds were obtained from Apalit when they alighted in a field of rice in head. One stomach was empty. Rice seeds in three stomachs comprised about 45 per cent of the food by number, while sabung-sabuñgan and daua-dauáhan in each of two stomachs made up 55 per cent.

In Tarlac Province twenty-three birds were obtained from three places during two days of collecting.

From the Municipality of Tarlac eighteen birds were collected October 18 and 19. From three of them no food was recovered. Rice seeds in three stomachs constituted about 3 per cent of the food. Seeds of six species of weed made up the balance. Daua-dauáhan was represented by 346 seeds constituting about 48 per cent. Other weeds noted were amor seco, sabung-sabuñgan, kolatai, agiñgai, and laau-láau. Weeds were noted in fifteen stomachs.

In a rice field at San Miguel three birds were taken. Fifty-four rice seeds, representing 55 per cent of the food, were recovered from two stomachs. Daua-dauáhan and amor seco were found in three stomachs.

The food of two birds from a rice field in Murcia was studied. Rice seeds made up 73 per cent of the food in both stomachs. Amor seco from one stomach filled the balance of 27 per cent.

Cabanatuan, Talavera, Santa Rosa, and Gapan, in Nueva Ecija, were visited for this study.

Five days collecting in an open field at Cabanatuan yielded forty-five birds. The places of collection were almost uniform as far as general ecological conditions were concerned. The nearest fields of rice in head were 5 kilometers distant. Three stomachs were empty. Of the contents of forty-two stomachs the rice seeds obtained from seven birds constituted less than 1 per cent. Weeds consisting of nine species made up the balance of slightly over 99 per cent. Tiribuhan and amor seco were represented by 5,043 and 3,737 seeds, respectively. Daua-dauáhan, sabung-sabuñgan, luya-luyáhan, alitbañgun, kabit-

kabit, *Cyperus* sp., and laau-láau were the other items noted. Weeds were recorded from forty stomachs.

October 10 two birds were shot in Talavera. Neither stomach contained anything but seeds of tiribúhan; one contained 240 and the other 273 seeds.

From Santa Rosa, where the birds were noted in a rice field, twenty-six stomachs were examined. Four were empty. From three stomachs eighteen seeds of rice were noted, representing less than 1 per cent. With a preponderance of amor seco, amounting to about 97 per cent, slightly over 99 per cent consisted of weeds belonging to ten species—amor seco, sabung-sabuñgan, daua-dauáhan, laau-láau, *Cyperus* sp., alitbañgun, katábad, batad-batádan, pásau-na-bilog, and kolatai. The weed seeds were noted in twenty-two stomachs.

In a field of rice in head at Gapan, Nueva Ecija, five weavers were obtained October 12. Thirty-seven rice seeds found in four stomachs constituted about 8 per cent of the food recovered from this lot. Daua-dauáhan obtained from one stomach represented about 76 per cent of the food. Amor seco was also present. Weeds were noted in two stomachs.

The food of eighty-seven weavers from Nueva Ecija consisted of 2.5 per cent rice seeds and 97.5 per cent weed seeds. Fourteen individuals, or about 18 per cent of the birds collected, had eaten rice; 66 individuals, or about 85 per cent, had fed on weeds.

The study of 282 weavers during October, 1932, in fifteen places in four provinces of the Central Plain shows that rice seeds constituted about 25 per cent of the food, and sixteen species of weed made up about 75 per cent.

Rice seeds were obtained from sixty-six stomachs, representing about 23 per cent of those collected during the month. Weed seeds from two hundred thirty-five individuals comprised about 83 per cent.

In November, 1932, while the rice crop in the vicinity was being harvested, collections of material for this study were made in Maketipo and Novaliches, both in Rizal Province, on the 23d and 25th, respectively. In six birds obtained from a patch of cogon, *Imperata cylindrica* Linn., at Maketipo, four stomachs contained about 7 per cent rice seeds. With amor seco outnumbering others, seeds belonging to six species of weeds were obtained from four stomachs. They were, besides amor seco,

daua-dauáhan, kolatai, *Cyperus* sp., batad-batádan, and kabit-kabit.

From a rice field in Novaliches, thirteen stomachs of weavers were studied. Rice seeds from eleven of them constituted about 28 per cent of the food recovered. Two stomachs were empty. Amor seco, kolatai, sabung-sabuñgan, *Cyperus* sp., and batad-batádan in varying amounts made up the balance of about 72 per cent. They were taken from eight stomachs.

Of the stomachs of nineteen birds collected in two neighboring places in November, when rice was in head, fifteen contained rice seeds constituting about 14 per cent of the food recovered. Weeds belonging to seven species were found in twelve stomachs, making up the balance of about 86 per cent.

Of the food of 628 Philippine weavers (Table 2), from thirty-six collecting places in nine provinces (fig. 1), from July to November, 1932, numerically, rice seeds constituted about 3 per cent and the seeds of at least eighteen species of weeds about 97 per cent. About 34 per cent of the birds collected had eaten rice seeds, while about 82 per cent had eaten weed seeds.

Field observations and stomach examination of the birds collected within this period have shown that among the weeds the species most abundant in any given locality is preferred by the birds. In collecting the materials studied, the places were not selected. Birds were shot wherever seen. Inasmuch as a large percentage of weed seeds was recovered from the stomachs, even if they were obtained from rice fields, it may be concluded that the birds preferred the weeds to rice.

The aggregate of the results obtained in two periods of study involving the volumetric and the numerical methods, respectively, of determining the amount of food taken, has been expressed in common by estimating the relation between the volumes of the seeds of rice and those of the different species of weeds noted.

Estimates based on actual measurement of their volume give the following number of seeds to occupy 1 cc of water: 63 rice, about 600 tiribúhan, about 800 daua-dauáhan, and about 1,900 amor seco. The volume of the seeds of fifteen other weeds was assumed to be the same as that of tiribúhan.

At this rate, 3,864 seeds of rice could be displaced by 62.66 cc; 62,113 seeds of amor seco by 32.16 cc; 12,855 seeds of daua-dauáhan by 16 cc; 21,657 seeds of tiribúhan by 36 cc and

TABLE 2.—*Value of Philippine weavers based on a numerical study of their foods.*

Locality and condition.	Collecting spot.	Date.	Birds collected.	Percentage composition of food (numerical).		Percentage of birds feeding.	
				Rice.	Weeds.	Rice.	Weeds.
Bulacan, San Jose del Monte: Rolling open field	Cogonal	July, 1932	10	--------	100	--------	100
Tungkong Manga: Open field	Vacant rice field	July, 1932	2	--------	100	--------	100
Rizal, Novaliches: Vacant rice fields and uncultivated fields	do	July, 1932	7	--------	100	--------	100
Tanay: Association of tikiw along the shore; corn in head; rice newly harvested.	Open shore of Laguna de Bay	July, 1932	25	4	96	28	40
Maketipo: Rolling field; rice newly transplanted	Vacant rice field	July, 1932	14	--------	100	--------	100
Cavite, Amadeo: Hilly, uncultivated field	Cogonal	July, 1932	1	--------	100	--------	100
Laguna, Agricultural College: Near campus	Lawn	July, 1932	1	--------	100	--------	100
Biñan: Grass association; newly plowed rice fields around	Grass association	Aug., 1932	13	--------	100	8	92
Biñan: Rice field, some are yet in head, others have been harvested.	Rice field; rice in head	Aug., 1932	13	24	76	82	53
Biñan: Open field, about 5 km from nearest rice field	Vacant rice field	Aug., 1932	20	6	94	50	75
Los Baños: Vacant rice fields; rice in head; coco groves	do	Aug., 1932	[a] 42	--------	100	--------	100
Pila: Vacant rice field; newly planted rice, coco groves, etc	do	Aug., 1932	10	1	99	10	100
Tayabas, Candelaria: Rice fields, coco groves, citrus orchards, etc.	Rice fields, rice in head	Aug., 1932	37	35	65	97	80
Mauban: Grassland, rice at young stage in the valley, coco groves on hills, sides and tops.	Open grassland	Aug., 1932	16	--------	100	6	100
Lucban: Extensive rice fields, grain in head	Rice field	Aug., 1932	71	8	92	61	86
Batangas, Balayan: Upland rice fields; sugar-cane fields; bamboo thickets, etc.	Small corn field near rice in head	Aug., 1932	7	20	80	71	100
Lemery: Road side, rice field and brush	Rice field, grain in head	Aug., 1932	5	2	98	40	80
Tanauan: Hilly extensive cultivated lands; diversified crops in practice.	do	Aug., 1932	12	23	77	58	42
Laguna, Los Baños: Vacant rice fields; rice in different stages	Rice field, rice in head	Sept., 1932	21	1	99	48	81

Bulacan, Pulilan: Open field, vacant rice field, rice field grain not in head.	Vacant rice field	Oct., 1932	21	--------	100	--------	100
Quingua: Open field; diversified crops in practice	In rice field grain not in head	Oct., 1932	46	--------	100	--------	100
Baliuag, District of Makinabang: Immediate surroundings planted to a variety of crops; rice not in head.	Vacant rice field	Oct., 1932	27	--------	100	7	100
Baliuag: Diversified crops in practice; rice in head nearby	Corn field	Oct., 1932	32	6	94	38	74
Bustos: Near a river, brush; rice field nearby	Vacant rice field	Oct., 1932	18	44	56	22	22
San Rafael: Rice fields, grain in head	-----do	Oct., 1932	28	16	84	82	82
San Ildefonso: Vacant rice fields at a distance	-----do	Oct., 1932	4	--------	100	--------	100
Pampanga, Apalit: Rice fields, grain in head; few vacant rice fields.	Rice field	Oct., 1932	5	45	55	60	40
Tarlac, Tarlac: Open field, cogonal; rice in different stages	Cogonal	Oct., 1932	18	3	97	17	83
San Miguel: Rice fields, grain in head; few vacant paddies	Rice field	Oct., 1932	3	55	45	67	100
Murcia: Rice in head and uncultivated fields	-----do	Oct., 1932	2	73	27	100	50
Nueva Ecija, Cabanatuan: Rice fields, grain in head nearby; vacant rice fields at intervals.	-----do	Oct., 1932	45	1	99	16	89
Talavera: Open rice fields; grain in head	-----do	Oct., 1932	2	0	100	0	100
Santa Rosa: Rice fields; grain in head at a distance	-----do	Oct., 1932	26	1	99	12	94
Gapan: Rice fields; vacant fields at intervals	-----do	Oct., 1932	5	8	92	80	40
Rizal, Maketipo: Rolling field; rice in harvest, etc	Cogonal	Nov., 1932	6	7	93	66	66
Novaliches: Rice in harvest	Rice field	Nov., 1932	13	28	72	85	62

[a] These birds, mostly young, came in numbers presumably to drink from nearly dried pools.

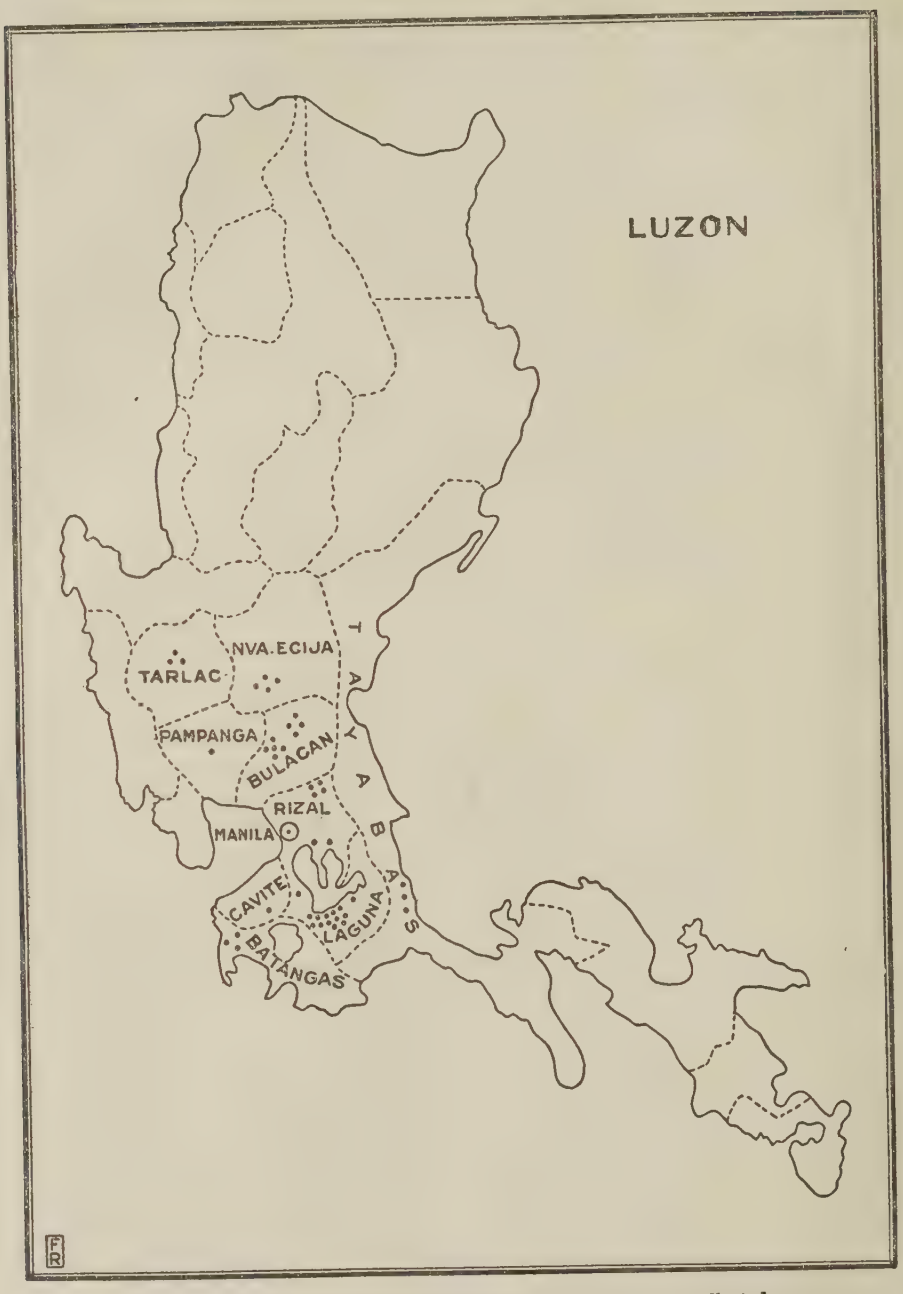

FIG. 1. Luzon, showing where Philippine weavers were collected.

the balance of 11,775 seeds of 15 other species of weeds by 19.6 cc. Therefore the percentages by volume of the food recovered during the five months of study are as follows: 3,868 rice seeds, 43; 118,400 weed seeds, 57.

These figures show a slight difference from those obtained during the first six months of study when 48 and 52 per cent of rice and weed seeds, respectively, were noted. The difference may partly be due to errors in measuring the volume of the different seeds recovered.

FOOD OF NESTLINGS

During the period of study eighteen nestlings were observed in their haunts at occasional intervals. Observations were made from the time they were hatched until they either died or left the nest. Due to the fact that male and female birds are indistinguishable, especially from a distance, it was not ascertained whether or not the adults take turns in feeding the nestlings.

Food was offered in the form of pellets and feeding generally took place in the morning and in the afternoon. Seed of weeds constituted the food of all the young observed. Although the number of seeds noted was not accurately determined, there was observed a difference in amount at various periods during the nesting season. A general proportionate increase of the number taken with the age was noted. It was roughly estimated, however, that a daily average of about three hundred weed seeds was fed to each nestling for about eighteen days. Considering that four young are hatched from a set of eggs, as the writer has pointed out,(8) and the inability of some of them to reach the flying stage, it is conservatively estimated that a daily destruction of about 1,000 seeds of weeds by the occupants of a single nest takes place. This will mean about 18,000 seeds during the nesting period. If it could be demonstrated that this number represents a check to the weed population, the benefit derived from this species of bird during the breeding season can further be estimated by noting the writer's observation to the effect that within an area of about 1,250 square meters, thirty-two nests were built among the citrus trees at one time.

FEEDING HABITS OF PHILIPPINE WEAVERS: THEIR EFFECT ON THE FOOD PLANT

The food of weavers has been found to be seeds of rice and weeds. Due, perhaps, to the fact that material was collected mostly in open fields, the observations of Roxas(11) that this

species of bird picked caterpillars of *Pericyma cruegeri* (Butler) was not verified by this study.

Food preference.—Stomach examinations showed that the greater percentage of the food of the Philippine weavers consisted of weed seeds. Preference for weed seeds becomes more obvious upon inspection of collecting grounds. In the collection of the birds wherever seen the greater number was obtained outside of rice fields. These are indications of the birds' preference for weed seeds to those of rice. An attempt to prove these results was made in the laboratory. Caged birds were given panicles of rice (milky and mature seeds) and those of amor seco, daua-dauáhan, tiribúhan, and laau-láau. After a series of five days of observation the birds preferred the seeds in the following order: Tiribúhan, amor seco, daua-dauáhan, milky rice seeds, laau-láau, and mature rice seeds. If this result be considered as occurring in nature, the percentage of rice seeds taken by the weavers would be greater than the estimate presented in this paper, as the milky rice seeds were not recovered in the stomachs included in the calculations.

Effect of the birds to the rice crop.—In the examination of the stomach contents of 628 weavers, a minimum of 1 and a maximum of 88 rice seeds were found. The extent of the damage done by this species, particularly to rice crops, will be an important contribution of this investigation. Generally accepted beliefs, including those of Camus(2) and Teodoro(12) concur as to the destructive effects of the species. It should be noted that all the figures obtained represent only one feeding time and do not indicate the possibility of the maximum extent of the value of the species to the plants fed upon. The stomachs of a few individuals contained 100 per cent rice seeds, but whether these birds feed exclusively on this grain throughout the day is not known. In order to approximate the number of seeds a bird destroys in one day, assuming that some of them feed wholly on this grain during the rice season, a series of experiments giving caged Philippine weavers a certain number of rice seeds throughout the day, was conducted. The grain was offered both to single and to paired birds. On the average, 178 and 174 rice seeds were taken by single and paired birds, respectively, during a period of twenty-four hours. The difference may have been due to the time spent by the paired bird in cooing, playing, or in driving away its mate from the Petri dish. The possibility of devouring more seeds under na-

tural conditions due to increased appetite caused by muscular exertion might be expected. Also, the birds may find it easier to pick the seeds from a panicle than from a dish. On the other hand, occasional disturbance during feeding, artificial devices to scare the birds and uncertainty of food supply will tend to limit the amount eaten. These two opposing factors may be considered as neutralizing each other.

The significance of these results appears better from the consideration that by actual count a liter was found to contain 25,480 rice seeds of the same variety as those fed to the birds. At the rate of 174 seeds a day (gregariousness of birds considered) it will take about 146 birds to consume a liter of rice seeds in one day or about 146 days for one bird to utilize the same amount. If the birds could have their full quota, 438 individuals could consume a ganta of rice seeds in one day. Uninterrupted visits of large flocks will certainly result in considerable damage to the crop. This estimate involves only the mature grain and does not take into account the crop in the milk stage which is considered by many as the state most heavily damaged by the birds. Although the result of experiments, described above, tends to confirm this belief actual field observations did not corroborate the accusation.

Effect of the bird on the weeds.—The data show that weed seeds are the preponderant food of the Philippine weavers. It is interesting to observe that as many as 3,624 seeds of amor seco, 808 of daua-dauáhan, 752 of tiribúhan, 672 of laau-láau, and 235 of sabung-sabuñgan were counted in one stomach. In addition, the number fed to thousands of young each year must be very great. The aggregate of weed seeds consumed by the species in one year is, undoubtedly, incalculable.

In Iowa, Beal(1) estimated that the annual consumption of one species of sparrow amounts to 875 tons of weed seeds. Whether the amount of seeds destroyed by the birds is a check to the yearly weed crop is not known. The tremendous amount of weed seeds produced each year, however, is too great to make the number destroyed by the birds of any significant value. In this connection Judd's(7) remarks are of interest. He states, "A single plant may mature as many as a hundred thousand seeds in a season, and if unchecked would produce in the third year ten billion plants." He refers to the effect of seed-eating birds as a control of this enormous increase. If the weavers hold the weed crop to a certain limit, there will also be

an effect on the population of the rice bug, which according to Uichanco(13) harbors temporarily on these plants until the rice attains the suitable stage for the insect. Quisumbing (1923) made the same observation.

Viability of voided materials.—It is generally conceded that birds are effective agents in the dispersion of plants. This has an important bearing on this study, for, if the Philippine weaver is an agent of dispersal of the enormous amount of weed seeds it takes every year, besides the damage to the rice crop, the species has, excepting its esthetic value, everything against it, and Dammerman's(5) contention that this belongs to a group of the most destructive birds could be reiterated herewith.

Six birds were placed in three cages, a pair in each. In each cage panicles of tiribúhan, sabung-sabuñgan, laau-laáu and amor seco were placed in the morning and left during the day. In the afternoon clean sheets of Manila paper were placed directly under the cages and left over night. The operation was repeated with rice seeds instead of weeds. The series was repeated four times. Droppings were collected at night and examined the following morning. There was not a whole seed found in the droppings. This result agrees with that of Judd,(7) who observed the habits of sparrows in the United States fed with different species of weeds.

The procedure was repeated by placing a seed box with sterilized soil under the cage instead of Manila paper. Nothing germinated in the seed box, indicating that Philippine weavers are not responsible for the dispersion through their fæces of any of the weeds tried in this experiment. Unfortunately, this result does not agree with the findings of Collinge,(3) who, working on the house sparrow, greenfinch, and bullfinch, was able to cultivate the weeds he obtained from the droppings of the bird. Harvey(6) was able to germinate the seeds of Virginia creeper obtained from the excrement of the English sparrow in Colorado, U. S. A. Pycraft(9) found that *Munia* aided considerably in the dispersal of adhesive seeds carried on the birds' wings.

SUMMARY

1. Owing to the fact that valuable results concerning the food habits of birds are obtained through stomach examination of adult birds, the greater part of the time in this investigation was spent on this method of study. The foods recovered are

expressed in percentages. The percentage of the birds feeding on both rice and weed seeds was also estimated.

2. Adult individuals were used in all the laboratory experiments reported in this paper.

3. Estimates of the value of the bird were grouped by places and by months. Final accounting was based on all birds studied.

4. The results of six months' study (December, 1926; January, March, 1927; April, May, and June, 1928) of 143 Philippine weavers, expressed volumetrically, are indicated in Table 1 and show that on the average 48 per cent rice seeds and 52 per cent weed seeds constitute the food of adult weavers.

5. Basing the estimate on the birds collected during this period, 66 per cent of the weavers feed on rice while 59 per cent feed on weeds. Except at one time, when the materials were obtained at Angono, Rizal Province, the specimens used during the period of study were collected in and around the College of Agriculture at Los Baños, Laguna Province.

6. Because of the almost uniform kind and size of seeds recovered from the stomach studied, the method employed in later examinations was changed from the volumetric to the numerical system.

7. The results of five months' study (July, August, September, October, and November, 1932) of 628 weavers, obtained in 36 collecting grounds belonging to 9 provinces, are shown in Table 2.

8. The final account shows that 3 per cent of the birds' food was rice seeds and 97 per cent was weed seeds. Converting these figures into terms of volume, the value becomes approximately 43 per cent rice and 57 per cent weed seeds.

9. Numerically, the four heaviest weeds recovered are amor seco, tiribúhan, daua-dauáhan, and sabung-sabuñgan.

10. Of the 628 individuals studied 35 per cent of the birds feed on rice, while 82 per cent feed on weed seeds.

11. The presence of daua-dauáhan in the rice fields saves the rice crop from the destruction of Philippine weavers, due probably to the birds' preference for this weed over rice.

12. Birds collected in rice fields when the grain is in head, generally feed largely on the seeds of this plant; those obtained away from such places feed extensively on weed seeds.

13. Evidence from collecting grounds, stomach contents, and laboratory experiments indicates that the birds prefer weeds

to rice. In the laboratory the seeds were preferred by the birds in the following order: tiribúhan, amor seco, daua-dauáhan, milkly rice seeds, laau-laáu, and mature rice seeds.

14. During the milk stage of the rice, the weavers were not observed to alight on the crop.

15. The food of weaver nestlings consists exclusively of weed seeds.

16. As many as eighty-eight seeds of rice were recorded from the stomach of an adult weaver. This represents only one feeding.

17. The average daily consumption of each bird, based on laboratory conditions, amounts to 174 mature rice seeds. At this rate it will take about 146 days for one bird to consume 1 liter of hard rice seeds or about 146 weavers to finish 1 liter in one day. Uninterrupted visits of large flocks will cause considerable damage.

18. As many as 3,624 seeds of one species of weed were recovered from one bird. This represents a record for only one feeding. The number of seeds destroyed annually by this species must be very great.

19. The weed seeds eaten by the birds probably represent a negligible part of the annual crop. Except where the birds may be a check on the excessive spread of weeds, the Philippine weaver may be considered of neutral importance as far as the weed item is concerned.

20. Seeds of tiribúhan, sabung-sabuñgan, laau-laáu and amor seco fed to the weavers were not recovered in the fæces. Planting of fæcal materials did not show that the seeds fed were viable.

CONCLUSIONS

This study indicates that the Philippine weaver is entirely a seed-eating bird, seeds of rice and weeds constituting its food. The species feeds, to a large extent, on weed seeds, and conditions being equal, prefers this food to the seeds of rice. Rice seeds constitute a small percentage of the food of the Philippine weavers studied, but some birds obtained in rice fields when the grain was in head fed largely on this grain. The prevailing methods of repelling the birds when the crop is in head should be encouraged as the Philippine weavers may turn their feeding activities entirely to the weed seeds. The young and adults feed chiefly on weed seeds during the nesting season. A large amount of weed seeds being destroyed by the Philippine weavers

does not appear significant, considering the tremendous annual crop.

The species is, therefore, harmful to a certain degree when the rice is in head, but otherwise of neutral importance.

List of food plants of Philippine weavers.

Gramineæ:
- Rice; *Oryza sativa* Linn.
- Agiñgai (Tag.); *Rottboellia exaltata* Linn.
- Amor seco (Tag.); *Andropogon aciculatus* Retz.
- Batad-batádan (Tag.); *Andropogon halepensis* (Linn.) Brot.
- Laau-laáu (Tag.); *Paspalum conjugatum* Berg.
- Tiribúhan (Tag.); *Panicum colonum* Linn.
- Daua-dauáhan (Tag.); *Panicum crus-galli* Linn.
- Sabung-sabuñgan (Tag.); *Panicum lavidum* Retz.
- Luya-luyáhan (Tag.); *Panicum repens* Linn.
- Agiñgai (Tag.); *Cenchrus viridis* Spreng.
- Kabit-kabit (Tag.); *Eleusine indica* (Linn.) Gaertn.
- Kolatai (Tag.); *Cynodon dactylon* Peters.
- Bocaui (Tag.); *Schizostachyum lumampao* (Blco.) Merr.

Cyperaceæ:
- *Cyperus* sp.
- Katábad (Tag.); *Scleria tessellata* Willd.

Euphorbiaceæ:
- *Phyllanthus simplex* Retz.
- Ibaibá-an (Tag.); *Phyllanthus urinaria* Linn.

Tiliaceæ:
- Pásau-na-bilog (Tag.); *Corchorus capsularis* Linn.

Commelinaceæ:
- Alitbañgun (Tag.); *Aneilema malabaricum* (Linn.) Merr.

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ILLUSTRATION

TEXT FIG. 1. Luzon, showing where Philippine weavers were collected. 419

DIE CALLIRRHIPIS-UNTERGATTUNG HELLERIOLA EMDEN, 1931 (COLEOPTERA; SANDALIDÆ)

ZUR KENNTNIS DER SANDALIDÆ 20; ZUGLEICH PHILIPPINISCHE SANDALIDÆ 3

Von Fritz van Emden

Dresden, Deutschland

Die Umgrenzung der Untergattung gab ich in den Entomologischen Blättern,[1] doch ist von den drei dort genanten Arten, den einzigen mir bekannten diese Gruppe, bisher keine beschrieben. Nachstehend veröffentliche ich diese drei Arten. Als Typus soll *Helleriana* m. gelten.

Die Unterschiede der Untergattung von *Callirrhipis* s. str. (Fühlerlamellen, wenigstens von der des 6. Gliedes ab, weniger als sechsmal so lang wie das zugehörige Glied) sind auffällig genug, und es würde kaum jemand versuchen, die beiden ersten Arten bei *Callirrhipis* unterzubringen. In praktischer Hinsicht ist also die Abtrennung dieser Artengruppe sicher erwünscht, da die Tiere das Bild von *Callirrhipis* s. str. zu sehr verwischen würden, wenn man sie dabei liesse. Auch der Habitus und die Skulptur der drei Arten sind verwandt. Dennoch ist es fraglich, ob die Gruppe durchaus natürlich ist, da der vordere Stirnteil bei den beiden anderen Arten abweichend gebaut ist und mit dem der *trepida*-Gruppe übereinstimmt, während er sich bei *Helleriana* an die *dissimilis*-Gruppe anschliesst. Gegen eine gar zu nachdrückliche Wertung dieses Merkmals spricht immerhin die Tatsache, dass sich darin auch das Männchen von *Callirrhipis helleri* Schultze, nicht jedoch das Weibchen—wenn ich dieses richtig bestimmt habe—und beide Geschlechter von *C. scutellata* Frm. wie die Mehrzahl der Callirrhipini verhalten, während ihre übrigen Merkmale kaum einen Zweifel an der Zugehörigkeit zur *trepida*- bzw. *lineata*-Gruppe aufkommen lassen. Ausser letzteren beiden Gruppen und *Helleriola henrikeni* und *laticornis* weist nur *Zenoa picea* Pal. den ausgeschnittenen Vorderteil der Stirn auf.

[1] Ent. Blätt. 27 (1931) 51.

Bestimmungstabelle der Arten.

1(2). Der vor den Fühlerhöckern befindliche Teil der Stirn plattenförmig vorgezogen und Clypeus und Oberlippe überdeckend. Halsschild ziemlich fein und wenig dicht punktiert. Präscutellareindrücke miteinander verflossen, doch nach aussen scharf abgegrenzt. Hauptpunktierung der Flügeldecken ziemlick fein, vier bis fünf Punkte bilden eine unregelmässige Querreihe. Die Fühlerlamellen vom 4. Glied ab wenig mehr bis weniger als zweimal so lang wie das zugehörige Glied. 2. bis 4. Tarsenglied höher als lang. Mindanao ..... *helleriana* sp. nov.

2(1). Der vor den Fühlerhöckern befindliche Teil der Stirn fällt steil ab und ist breit halbkreisförmig ausgerandet, Clypeus und Oberlippe frei. Halsschild wenig fein bis grob, sehr dicht punktiert. Präscutellareindrücke flach oder tief, in der Mittellinie jedoch sehr deutlich getrennt. Hauptpunktierung der Flügeldecken ziemlich grob, zwei bis drei Punkte bilden eine unregelmässige Querreihe.

3(4). Tarsen schlank, 2. und 4. Glied länger als hoch. Fühlerglieder ziemlich lang, Lamellen kurz, die des 4. Gliedes weniger als dreimal so lang wie das zugehörige Glied. Präscutellareindrücke klein und wenig tief, voneinander durch die auch an der Basis nicht niedergedrückte sondern gewölbte Umgebung der Mittellinie sehr deutlich, von den übrigen Eindrücken wenig auffällig getrennt. Behaarung ziemlich lang, anliegend, am Seitenrand der Flügeldecken von vor der Mitte an struppig abstehend. Sumatra. *henrikseni* sp. nov.

4(3). Tarsen weniger schlank, das 2. und 4. Glied etwas höher als lang. Fühlerglieder mässig lang, die Lamellen ziemlich gross, besonders die basalen, die des 4. Gliedes fast achtmal, die des 6. etwa fünfmal, die des 10. etwa dreimal so lang wie das zugehörige Glied. Präscutellareindrücke sehr gross und tief, voneinander und von den übrigen Eindrücken durch breite, stark erhabene Wülste getrennt. Behaarung anliegend und ziemlich kurz, besonders auf dem grössten Teil der Flügeldecken, am Seitenrand der letzteren regelmässig nach hinten gekrümmt, kurz und ziemlich anliegend. Borneo ..... *laticornis* sp. nov.

CALLIRRHIPIS (HELLERIOLA) HELLERIANA sp. nov.

Männchen; Mindanao, Kolambugan; Baker, Typus Mus. Dresden. Schwärzlich graubraun, wenig lang anliegend graugoldgelb behaart, Fühler, Schienen und Tarsen dunkel rotbraun, Taster rotbraun. Die Behaarung etwas unregelmässig gelagert, ohne jedoch eine merkliche Scheckung zu erzeugen. Kopf mässig dicht, ziemlich grob und tief punktiert. Zweites und drittes Kiefertasterglied gleich lang, um einhalb länger als breit, das letzte fast doppelt so lang, zweimal so lang wie breit. Fühler dreiviertel so lang wie der Körper, das 3. Glied fast zwei und dreiviertelmal, das 4. reichlich viermal, das 10. reichlich fünfmal so lang wie dick, die Lamelle des 3. Gliedes fast zwei und

dreiviertelmal, die des 10. Gliedes fast ein und dreiviertelmal so lang wie das zugehörige Glied, das 11. Glied flach nach innen gebogen, so lang wie das 10., 9. und die reichliche Hälfte des 8. zusammen. Halsschild breit, die vordere Hälfte kräftig und ziemlich gleichmässig gerundet, die Seiten ziemlich flach aber sehr deutlich ausgerandet, der Seitenrandeindruck selbst jedoch sehr schwach, die Seiten vor den Hinterecken geradlinig und fast parallel, nur sehr schwach nach hinten divergierend. Die herabgeschlagenen Vorderecken als gerundete Augenlappen verhältnismässig kräftig vorgezogen, bei binokularer dorsaler Betrachtung eben zu bemerken. Halsschildpunktierung wenig fein, ziemlich tief, etwas ungleichmässig, wenig dicht, die Zwischenräume nahe der Mitte etwas ölig verfliessend. Discoidaleindruck klein und tief, Präscutellareindrücke gross und tief, miteinander vershmolzen, doch nach aussen scharf begrenzt, Hintereckeneindruck gross und ziemlich tief. Halsschild in den apikalen drei Fünfteln flach und gleichmässig gewölbt, vor der Basis abgeflacht. Schultern wenig breiter als die Halsschildbasis, sehr flach gerundet. Die Flügeldecken bis fast ans Ende des 3. Fünftels leicht gerundet sehr schwach erweitert, von da zur Spitze in sehr flacher Rundung verengt, am Ende abgerundet-sugespitzt. Die Rippen wenig scharf begrenzt, breit und flach erhaben, die 1. endet frei, die 2. vereinigt sich mit dem Ende der 4., die 3. nur hinter der Schulter ein kurzes Stück deutlich, unter der Schulter aus der Basis der 4. entspringend, die Vereinigung der Rippen endet ziemlich weit vor der Spitze frei. Die Fläche zwischen den Rippen leicht konkav und stellenweise etwas geknittert. Hauptpunktierung der Flügeldecken ziemlich fein und wenig dicht, es bilden vier bis fünf Punkte eine unregelmässige Querreihe, zwischen je zwei Punkten haben ein bis drei weitere Platz. Grundpunktierung ziemlich fein und wenig dicht, leicht runzlig verbunden. Flügeldecken im Basaldrittel mässig gewölbt, im mittleren Drittel fast geradlinig, im Enddrittel erst schwächer, dann stärker abwärts gewölbt, der Breite nach mässig gewölbt. Schienen mässig schlank, die Hinterschienen in der Mitte leicht eingebogen, Tarsen wenig schlank, das 2. bis 4. Tarsenglied höher als lang, das Klauenglied schon im Basaldrittel breiter als die vorhergehenden Glieder. Länge 15,5, Schulterbreite 4,5, Fühlerlänge 12 mm.

Ausser den in der Tabelle angegebenen Merkmalen durch bedeutendere Grösse, viel längere Fühler, mehr graubraune Färbung und das Fehlen eines vollständigen Haarwirbels in den

Basaleindrücken der Flügeldecken von den beiden anderen Arten auffällig abweichend.

CALLIRRHIPIS (HELLERIOLA) HENRIKSENI sp. nov.

Vier Männchen, Sumatra: Si-Rambé 12. 1890–3. 1891, E. Modigliani, Mus. Kopenhagen (davon ein Mus. Dresden) (Cotypen); Männchen, Sumatra, Solok, P. O. Stolz (Mus. Leyden) (Cotypus); Männchen, Sumatra, Loeboe Raja, A. L. v. Hasselt, Mus. Leyden (Cotypus).

Dunkel rotbraun, Taster, Fühler, Schienen und Tarsen rotbraun. Behaarung goldgelb, wechselnd gelagert, eine leichte Scheckung erzeugend, ziemlich lang, anliegend, jedoch am Seitenrand der Flügeldecken in den distalen drei Fünfteln struppig abstehend, in den Basaleindrücken der Flügeldecken sternförmig gelagert, also einen Wirbel bildend. Kopf wenig dicht, tief und wenig grob punktiert. Drittes Glied der Kiefertaster fast so lang wie das 2., ein Viertel länger als breit, letztes spindelförmig zugespitzt und etwas nach innen gebogen. Fühler zwei Drittel bis drei Viertel (0,65–0,74 so lang wie der Körper, das 3. Glied zwei und ein Viertel bis swei und drei Viertelmal, meist fast genau zwei und ein halbmal, das 4. drei und ein halb bis viermal, das 10. etwa vier und ein halbmal so lang wie dick, die Lamelle des 3. Gliedes dreimal, die des 10. zweimal so lang wie das zugehörige Glied, das 11. Glied flach gerundet nach innen gebogen, wenig kürzer als das 8. bis 10. zusammen. Halsschild kurz und breit, flach halbkreisförmig gerundet, die Rundung vor der Mitte infolge der schmalen und wenig auffälligen Seitenrandeindrücke etwas abgeflacht oder leicht ausgerandet, vor der Basis fast geradlinig oder (Solok) schwach gerundet etwas erweitert. Die herabgeschlagenen Vorderecken als gerundete Augenlappen ziemlich kräftig vorgezogen, bei binokularer dorsaler Betrachtung deutlich sichtbar. Halsschildpunktierung wenig fein, ziemlich tief, dicht und gleichmässig. Discoidaleindrücke ziemlich gross und ziemlich tief, nach hinten-aussen breit mit den grossen Hintereckeneindrücken verfliessend. Präscutellareindrücke klein und wenig tief, voneinander durch die auch an der Basis nicht niedergedrückte sondern gewölbte Umgebung der Mittellinie sehr deutlich, von den übrigen Eindrücken nur breit, flach und wenig auffällig getrennt. Halsschild in den basalen zwei Dritteln eben, zur Spitze wenig stark abwärts gewölbt, der Breite nach sehr flach gewölbt. Schultern deutlich breiter als die Halsschildbasis, breit gerundet, Flügeldecken bis ans Ende des 1. Drittels ganz schwach verengt,

fast parallel, von da bis ans Ende des 2. Drittels ebenso schwach erweitert, zur Spitze in flacher Rundung stark verengt, am Ende spitz abgerundet. Die inneren Rippen durch die sie reihig begleitende Hauptpunktierung gut begrenzt, doch kaum merklich erhaben, die 1. mündet in die 2. oder endet frei, die 3. und 4. meist undeutlich, sich mehr oder weniger undeutlich miteinander und dann mit der Verlängerung der 1. und 2. verbindend, die gemeinsame Verlängerung aller Rippen mündet deutlich oder undeutlich nahe der Spitze in die Naht. Die Fläche zwischen der 2. Rippe und der Naht, in wenig deutlichem Masse auch die zwischen der 2. und 3. Rippe stellenweise konkav, besonders hinter der Mitte mit einigen fast grübchenförmigen Eindrücken. Hauptpunktierung der Flügeldecken ziemlich grob und dicht; es bilden zwei bis drei Punkte eine unregelmässige Querreihe; zwischen je zwei Punkten hat meist nur oder kaum ein weiterer Platz. Grundpunktierung mässig fein und ziemlich zerstreut bis wenig dicht. Flügeldecken im Basaldrittel schwach bis mässig gewölbt, im übrigen fast geradlinig und nur zur Spitze leicht gerundet abfallend. Schienen schlank, die Hinterschienen gegen die Mitte schwach eingebogen. Tarsen schlank, alle Glieder länger als hoch, besonders das, 1. Glied, dieses vor allem an den Vordertarsen sehr schlank, aber selbst an den Hintertarsen noch fast dreimal so lang wie hoch. (Bei ein Stück von Si-Rambé sind beide Vorderbeine symmetrisch unverhältnismässig verkürzt aber normal gegliedert und nur weniger schlank. Es handelt sich wahrscheinlich um Regenerate von auf frühem Larvenstadium verlorengegangenen Extremitäten. Das symmetrische Auftreten braucht dem bei der eng benachbarten Einlenkung der kurzen Larvenbeine nicht zu widersprechen.) Länge 10 bis 12, Schulterbreite 3,0 bis 3,5, Fühlerlänge 7,2 bis 8,6 mm.

Von der folgenden Art besonder durch viel schlankere Gestalt und viel kürzere Fühlerlamellen des Männchens auffällig unterschieden.

CALLIRRHIPIS (HELLERIOLA) LATICORNIS sp. nov.

Männchen, Borneo, Museum für Naturkunde, Stettin (Typus).—Dunkel rotbraun, Taster, Fühler, Schienen und Tarsen hell rotbraun, Behaarung der Flügeldecken verschieden gelagert, eine leichte Scheckung erzeugend. Kopf wenig dicht und wenig grob punktiert. Zweites und drittes Kiefertasterglied gleich lang, so lang wie breit, das 4. swei und ein halbmal so lang wie das 3. und ebenso breit. Fühler reichlich drein Fünftel so

lang wie der körper, das 3. Glied anderthalbmal, das 4. etwa zweimal, das 10. viermal so lang wie dick, die Lamelle des 3. Gliedes reichlich neunmal, die des 10. dreimal so lang wie das zugehörige Glied, das 11. Glied an der Spitze etwas eingebogen, etwa so lang wie das 7. bis 10. Glied zusammen. Halsschild sehr kurz und breit, die vordere Hälfte sehr breit und gleichmässig gerundet, die Seiten sehr tief ausgerandet, der Seitenrandeindruck kräftig, die Seiten zu den Hinterecken kräftig gerundet. Die herabgebogenen Vorderecken als gerundete Augenlappen stark vorgezogen, bei binokularer dorsaler Betrachtung deutlich erkennbar. Halsschildpunktierung grob, tief, ziemlich dicht, etwas unregelmässig, die Zwischenräume jederseits der Mitte etwas querrunzlig verfliessend. Discoidaleindrücke wenig gross und mässig tief, Präscutellareidrücke gross und sehr tief, voneinander und von den anderen Eindrücken sehr scharf getrennt, Hintereckeneindrücke gross und wenig tief. Halsschild in den apikalen zwei Fünfteln ziemlich stark gewölbt, dahinter flach und leicht konkav abfallend. Schultern wenig breiter als die Halsschildbasis, ziemlich flach gerundet. Flügeldecken hinter den Schultern flach und breit ausgeschweift, bis ans Ende des 3. Fünftels leicht erweitert, von da zur Spitze in sehr flacher Rundung verengt, am Ende schmal abgerundet-zugespitzt. Die Rippen kaum merklich gewölbt, in der Hauptsache durch das Fehlen der Hauptpunktierung erkennbar, die 1. endet frei, die 2. vereinigt sich mit der sehr undeutlichen und vor der Vereinigung durch den grossen Eindruck der Zwischenräume überlagerten 3. und dem Ende der 4. Rippe. Die Flügeldecken besitzen kräftige Eindrücke innerhalb der Schultern, hinter dem Schildchen zwischen Naht und 1. Rippe, hinter den Schultern innerhalb des Seitenrandes, vor der Spitze zwischen 2. Rippe und Naht und vor der Vereinigung der 2. bis 4. Rippe. Hauptpunktierung der Flügeldecken grob bis sehr grob, mässig dicht, es bilden zwei bis vier Punkte eine unregelmässige Querreihe, zwischen je zwei Punkten hat meist nur ein Punkt Platz. Grundpunktierung wenig fein und ziemlich dicht. Flügeldecken im Basaldrittel ziemlich stark gewölbt, von da zur Spitze fast geradlinig und erst unmittelbar vor ihr wieder etwas schräger abfallend. Schienen ziemlich schlank, gegen die Mitte leicht eingebogen, Tarsen ziemlich schlank, das 2. bis 4. Tarsenglied etwas höher als lang. Das Klauenglied etwa von der Mitte ab breiter als die vorhergehenden Glieder. Länge 13,5, Schulterbreite 4,2, Fühlerlänge 8,5 mm.

Durch die zur Spitze ziemlich stark verbreiterten, für diese Untergattung verhältnismässig langen Fühlerlamellen sehr ausgezeichnet.

Es liegt mir noch ein 2. vielleicht zu dieser Art gehöriges Stück (Borneo Samml. Halsschild, Universitetets Zoologiske Museum, Kopenhagen) vor, bei dem die Fühler fast vollständig fehlen, der Halsschild viel schwächer gewölbt und fein und dicht punktiert ist, die Hauptpunktierung der Flügeldecken weniger dicht ist und die Halsschildvorderecken viel schwächer vorgezogen sind. Da das 4. bis 11. Fühlerglied fehlen, kann es sich jedoch auch um eine *Callirrhipis* s. str. aus der Verwandtschaft der *C. glabra* Pic handeln.

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NEW OR LITTLE-KNOWN TIPULIDÆ FROM THE PHILIPPINES (DIPTERA), XVII[1]

By Charles P. Alexander

Of Amherst, Massachusetts

THREE PLATES

The present report on the rich tipulid collections made in the Philippines by my friends Messrs. Charles F. Clagg, Richard C. McGregor, and Francisco Rivera is devoted entirely to species from Luzon and Mindanao. The genera *Trichoneura* and *Troglophila* are added to the record for the Islands. A revised key to the species of *Trentepohlia* is supplied. Especially noteworthy is the large number of additions made to the list of the small and obscure species of the eriopterine genera *Gonomyia* and *Erioptera*. My continued gratitude to the above-mentioned entomologists is heartily extended for the privilege of retaining the types of the novelties in my own collection.

LIMONIINÆ

LIMONIINI

LIMONIA (LIMONIA) LANGUIDA sp. nov. Plate 1, fig. 1; Plate 2, fig. 25.

Allied to *davaoensis;* mesonotal præscutum yellow, with three brown stripes on the posterior portion of disk; pleura with a conspicuous black longitudinal stripe; halteres brownish black; femora brown, the tarsi and distal ends of tibiæ paling to obscure yellow; male hypopygium with the basistyle bearing two very unequal lobes on mesal face; a single complex dististyle; gonapophyses elongate, the outer margin strongly corrugated.

Male.—Length, about 3 millimeters; wing, 3.8.

Rostrum and palpi black. Antennæ black throughout; flagellar segments elongate-oval, with short, stout apical pedicels; verticils relatively stout and inconspicuous, shorter than the segments; terminal segment elongate, exceeding one and one-half times the length of the penultimate. Head dark gray.

Mesonotal præscutum chiefly light yellow, with three more or less distinct brown stripes on the posterior two-thirds, the

[1] Contribution from the entomological laboratory, Massachusetts State College.

cephalic third without markings; lateral stripes narrow; lateral margin of sclerite weakly darkened; lobes of scutum darkened; remainder of mesonotum chiefly obscure yellow. Pleura pale yellow, with a narrow but conspicuous longitudinal black stripe, broadest in front, narrowed behind, passing beneath the halteres. Halteres brownish black, the basal fourth of stem light yellow. Legs with coxæ and trochanters very pale yellow, only the fore coxæ a little darker; femora and tibiæ brown, the latter toward their tips, together with tarsi, paling to obscure yellow; claws slender, with a relatively small basal tooth and an elongate seta. Wings (Plate 1, fig. 1) grayish subhyaline, the prearcular and costal regions very weakly infumed; stigma short-oval, darker brown; veins dark brown. Macrotrichia of veins relatively long and conspicuous. Venation: Sc_1 ending about opposite two-fifths the length of Rs, Sc_2 not far from its tip; m-cu at fork of M.

Abdomen brownish black, including the hypopygium. Male hypopygium (Plate 2, fig. 25) with the caudal margin of tergite, 9*t*, broadly and convexly rounded. Basistyle, *b*, with a very large flattened ventromesal lobe, in addition to a much smaller, dusky, clavate lobule. Only a single dististyle, *d*, is evident in the material on hand, the body divided into two fingerlike lobes that are provided with long coarse setæ, those of the slenderer lobe slightly longer; rostral prolongation elongate, flattened, without evident rostral spines. Gonapophyses, *g*, elongate, the outer margin conspicuously corrugated.

LUZON, Tayabas Province, Lucban, January 26, 1931 (*Rivera*); holotype, male.

The general structure of the basistyle, dististyle, and gonapophyses of the male hypopygium shows the present species to be allied to a small group of Philippine species centering about *Limonia* (*Limonia*) *davaoensis* Alexander, such as this latter species and *L.* (*L.*) *bilobulifera* Alexander. It differs very evidently in the structure of the male hypopygium, being most similar to *bilobulifera*, but still quite distinct in the details of both venation and hypopygium.

LIMONIA (LIMONIA) ERRATICA sp. nov. Plate 1, fig. 2; Plate 2, fig. 26.

General coloration dark brown, the pleura obscure yellow; anterior vertex silvery; legs black, the tarsi and tips of tibiæ paling to yellow; wings with a strong brown suffusion; Sc long, Sc_1 ending about opposite four-fifths the length of Rs; free tip of Sc_2 lying distad of R_2, R_{1+2} projecting as a long spur beyond

either of these elements; m-cu close to fork of M; abdominal tergites brownish black, the sternites yellowish; male hypopygium with the ventral dististyle fleshy, much larger than the basistyle, the rostral prolongation with two spines; caudal border of tergite weakly bilobed.

Male.—Length, 5.5 to 6.3 millimeters; wing, 6 to 7.

Rostrum and palpi black. Antennæ black throughout; flagellar segments long-oval to subcylindrical, the verticils relatively short, less than the segments in length; terminal segment elongate, at apex narrowed into a button. Head blackish, the broad anterior vertex silvery.

Mesonotum and pleurotergite uniformly dark brown. Pleura obscure yellow, the propleura blackened. Halteres brownish black, the base of stem narrowly pale. Legs with the fore coxæ blackened, the remaining coxæ and all trochanters obscure yellow; femora black, slightly brightened at bases; tibiæ brown, their tips and all tarsi paling to obscure yellow; claws relatively small, nearly straight, each with two slender setiform spines at base, the outer one larger. Wings (Plate 1, fig. 2) with a strong brown tinge, the costal region and cell Cu_1 slightly darker; stigma oval, darker brown; veins dark brown. Costal fringe dense but rather short. Venation: Sc long, Sc_1 ending about opposite four-fifths the length of the long Rs, the latter narrowly angulated at origin; free tip of Sc_2 and R_2 both pale, opposite one another, or the latter lying proximad of the former, R^{1+2} jutting some distance beyond these veins as a spur, provided with trichia; m-cu close to fork of M.

Abdominal tergites and hypopygium brownish black; sternites obscure yellow. Male hypopygium (Plate 2, fig. 26) with the tergite, 9*t*, strongly narrowed apically, the caudal margin gently emarginate, each lobe thus formed with a close group of about eight long coarse setæ. Basistyle, *b*, short and stout, the ventromesal lobe occupying almost the whole mesal face. Ventral dististyle, *vd*, large and fleshy, the rostral prolongation slender, with two spines that are placed close together, these subequal in length to the prolongation itself. Gonapophyses, *g*, very broad, the mesal-apical lobe relatively short, its margin irregularly and weakly roughened but scarcely serrulate.

LUZON, Tayabas Province, Lucban (*Rivera*); holotype, male, January 25, 1931; paratypes, 3 males, January 24–26, 1931; MINDANAO, Cotobato Province, Mount Matutum, April 29, 1932 (*Rivera*); paratypes, 2 males.

In the characters listed in the above diagnosis, *Limonia* (*Limonia*) *erratica* differs widely from the other Philippine species of the subgenus, with the single exception of *L.* (*L.*) *melanoptera* sp. nov. The male hypopygium of both of these species is very similar to that of *Dicranomyia* but the unusually long Sc requires the assignment of the flies to *Limonia*. In the projection of vein R_{1+2} as a spur beyond the level of either R_2 or the free tip of Sc_2 the present fly is distinct from the other Philippine species of the subgenus.

LIMONIA (LIMONIA) MELANOPTERA sp. nov. Plate 1, fig. 3; Plate 2, fig. 27.

General coloration of thorax dark fulvous or brownish yellow; antennæ black, the verticils much shorter than the segments; legs brownish black; wings strongly suffused with blackish, cells C and Sc darker; Sc long, Sc_1 ending just before the fork of Rs; R_{1+2} not projecting beyond level of R_2; abdomen black; male hypopygium with caudal margin of tergite convexly rounded.

Male.—Length, about 5 to 5.5 millimeters; wing, 6 to 6.8.

Rostrum and palpi black. Antennæ black throughout, relatively elongate (male); flagellar segments long-oval to subcylindrical, with very short apical necks; segments clothed with a dense abundant erect pubescence and scattered verticils that are only about one-third the length of the segments. Head black; anterior vertex reduced to a capillary line or virtually lacking by approximation of eyes.

Pronotum almost hidden beneath the cephalic margin of præscutum, black. Mesonotal præscutum dark fulvous or brownish yellow, the scutal lobes weakly darkened, especially along their mesal and cephalic edges; scutellum more infuscated, the posterior edge pale. Pleura brownish yellow, polished. Halteres dusky. Legs with coxæ and trochanters obscure yellow; femora brownish black, the narrow bases obscure yellow; tibiæ and tarsi passing into black. Wings (Plate 1, fig. 3) strongly suffused with blackish, cells C and Sc, with the oval stigma, darker brown; veins brownish black. Venation: Sc long, Sc_1 ending just before fork of Rs, Sc_2 at its tip; m-cu at or close to fork of M; cell 1st M_2 relatively small.

Abdomen, including hypopygium, black. Male hypopygium (Plate 2, fig. 27) with the caudal margin of the tergite, 9*t*, evenly and strongly convex, not bilobed as in *erratica*. Basistyle, *b*, with two separate ventromesal lobes, the more apical one smaller. Ventral dististyle, *vd*, large and fleshy, the rostral prolongation with two spines of moderate length.

LUZON, Mountain Province, Benguet, Clark's Place, Camp 66, altitude 7,000 feet, October 6, 1931 (*Rivera*); holotype, male, paratypes, 2 males; Bontoc, Mount Data, altitude 6,000 feet, October 9, 1931 (*Rivera*); paratype, male.

The only regional species of the subgenus that has a somewhat similarly darkened wing pattern and bispinous rostral prolongation of the male hypopygium is *Limonia* (*Limonia*) *erratica* sp. nov. The present fly differs in numerous respects, as the more elongate antennæ, with unusually short verticils; dark brownish yellow thorax; blackened tibiæ and tarsi; and in the details of venation and structure of the male hypopygium, as discussed above.

LIMONIA (LIMONIA) PARVISPICULATA sp. nov. Plate 1, fig. 4; Plate 2, fig. 28.

General coloration of præscutum and scutal lobes brownish black, pleura obscure yellow; antennæ black throughout; legs dark brown, the tarsi paler; wings with a brownish tinge; male hypopygium with the ventral dististyle an oval structure, the outer margin narrowly blackened, the rostral prolongation represented only by a small peglike spine that is placed beyond midlength of the style.

Male.—Length, about 3.5 millimeters; wing, 4.2.

Rostrum and palpi black. Antennæ black throughout; flagellar segments oval, with short stout apical pedicels; longest verticils a trifle shorter than the segments; terminal segment longer than the penultimate, strongly narrowed outwardly. Head blackish, sparsely pruinose; anterior vertex and posterior orbits lighter gray.

Disk of mesonotal præscutum and the scutal lobes brownish black, the lateral portions of the præscutum broadly obscure yellow; posterior sclerites of mesonotum dark brown. Pleura obscure yellow. Halteres blackened, the base of stem restrictedly pale. Legs with the coxæ and trochanters obscure yellow; femora and tibiæ dark brown, the tarsi paling to light brown; claws relatively long and slender, with a long narrow basal spine and additional elongate setæ. Wings (Plate 1, fig. 4) with a brownish tinge, the oval stigma only a trifle darker; veins brown. Costal fringe relatively long and conspicuous; macrotrichia of veins basad of cord sparse or lacking, there being none on basal section of Cu_1 or on the anal veins, excepting a single apical one on each of the anals. Venation: Sc relatively short, Sc_1 ending about opposite two-fifths the length of Rs, Sc_2 at its tip; free tip of Sc_2 lying slightly proximad of

R_2, both elements pale and without macrotrichia; inner end of cell 1st M_2 arcuated; m-cu variable in position, in one wing of type at fork of M, in the opposite wing at near one-third the length of cell.

Abdominal tergites brownish black; basal sternites dusky in color, narrowly margined caudally with paler. Male hypopygium (Plate 2, fig. 28) with the tergite, 9*t*, divided into two broad lobes by a median notch. Basistyle, *b*, relatively slender, the ventromesal lobe small, cushionlike, placed at cephalic end of style. Dorsal dististyle a pale ribbonlike blade that narrows very gradually to the acute tip. Ventral dististyle, *vd*, an oval structure, the outer margin narrowly blackened to apex; no rostral prolongation except a small peglike spine placed beyond midlength of style. Gonapophyses, *g*, with the mesal-apical lobe dusky, its apex unequally bidentate.

LUZON, Tayabas Province, Lucban, January 26, 1931 (*Rivera*); holotype, male.

The very peculiar structure of the ventral dististyle of the male hypopygium readily separates the present fly from the now numerous small regional species of *Limonia*. The structure of the dististyle and the wing venation remotely suggest *Limonia* (*Limonia*) *retrusa* Alexander (Luzon), which differs very evidently in the details of the styli and gonapophyses.

LIMONIA (LIBNOTES) CIRCUMSCRIPTA sp. nov. Plate 1, fig. 5; Plate 2, fig. 29.

Belongs to the *familiaris* group; mesonotum chiefly black, the sides of præscutum broadly deep reddish; knobs of halteres blackened; fore femora black, except the narrow yellow bases; wings whitish subhyaline, the prearcular region extensively and conspicuously pale yellow; costal region and a seam almost around wing margin brown; abdomen, including hypopygium, black; outer rostral spine of male hypopygium unusually long and slender.

Male.—Length, about 8 millimeters; wing, 9.3.

Rostrum and palpi black. Antennæ with scape and pedicel black; flagellum broken. Head dull grayish black; anterior vertex reduced to a linear strip.

Pronotum black. Mesonotal præscutum deep reddish, with a single broad black median stripe; remainder of mesonotum black. Pleura chiefly brownish yellow, the dorsal sclerites somewhat darker. Halteres yellow, the knobs blackened. Legs with the coxæ dark reddish brown; trochanters obscure yellow; femora yellow basally, the tips black, on forelegs only the very

narrow bases brightened, on middle and hind legs the coloration of the extensive central portion more brownish, the tips narrowly blackened; tibiæ brownish black; tarsi passing into black. Wings (Plate 1, fig. 5) whitish subhyaline, the prearcular region abruptly and conspicuously pale yellow; cells C and Sc dark brown, about as intense in color as the subcircular stigma; the entire border of wing, excepting the axilla, is broadly and distinctly clouded with brown, broadest at the apex; seams at origin of Rs, along cord and outer end of cell 1st M_2 extremely restricted to almost lacking; cell Cu_1 (between branches of Cu) darkened; veins brown, darker in the clouded areas. Venation: Sc_1 ending beyond the level of the shortened r-m, Sc_2 some distance from its tip but very ill-defined; Rs and basal section of R_{4+5} almost in feebly oblique alignment; m-cu about its own length beyond the fork of M; anal veins at base feebly divergent.

Abdominal tergites black, the sternites almost as deeply colored; hypopygium black. Male hypopygium (Plate 2, fig. 29) with the tergite, 9*t*, deeply notched medially, the setæ marginal. Ventral dististyle, *vd*, large and fleshy, the rostral spines unequal in length and size, the outer one unusually long and straight; rostral prolongation beyond the last spine pendant. Dorsal dististyle stout on more than basal half, strongly curved, the outer portion very slender and acute.

LUZON, Mountain Province, Bontoc, Mount Data, altitude 6,000 feet, October 9, 1931 (*Rivera*); holotype, male.

By Edwards's key to the species of *Libnotes* [2] the present fly runs to couplet 59, disagreeing with the included species and all others in the key and described since its publication by the peculiar wing pattern, as described. The following Philippine species, *Limonia* (*Libnotes*) *melancholica* Alexander, *L.* (*L.*) *neofamiliaris* Alexander, *L.* (*L.*) *subfamiliaris* Alexander, and *L.* (*L.*) *unistriolata* Alexander, all have a somewhat similar type of male hypopygium, but all differ in the uniform nature of the wing pattern, with no prearcular brightening.

LIMONIA (LIBNOTES) RARISSIMA sp. nov. Plate 1, fig. 6; Plate 2, fig. 30.

General coloration yellow, the præscutum with a narrow median brownish black stripe; scutellum and mediotergite blackened; femora black, the narrow bases and tips yellow, the amount subequal at the two ends; tibiæ and tarsi brownish

[2] Journ. Fed. Malay States Mus. 14 (1928) 74–80.

yellow; wings pale yellow, the cord and outer end of cell 1st M_2 conspicuously seamed with brown; Sc_2 elongate; m-cu long; male hypopygium with the ventral dististyle large and fleshy; rostral prolongation with two unequal spines, the outermost stouter, curved toward tip.

Male.—Length, about 7.5 to 8 millimeters; wing, 8 to 8.5.

Female.—Length, about 8 millimeters; wing, 8.2.

Rostrum and palpi black, the former one-third the length of the remainder of head. Antennæ (male) greenish black, in life probably clear green; flagellar segments subglobular to short-oval, with short necks; in female, flagellar segments darker in color and more elongate-oval. Head blackish; anterior vertex reduced to a linear strip.

Pronotum black. Mesonotal præscutum obscure yellow, with a single brownish black median stripe; scutal lobes with centers similarly darkened; scutellum black, with indications of a capillary pale median vitta; mediotergite blackened, the cephalic lateral portions more yellowish. Pleura yellow or greenish yellow, in male with restricted darkened areas on anepisternum and before root of halteres. Halteres pale greenish, the knobs more yellowish. Legs with the coxæ and trochanters yellow; only a single leg (fore) remains; femora black, the tips and bases narrowly but conspicuously yellow, the amount subequal on both ends; tibiæ and tarsi brownish yellow, the terminal tarsal segments darkened. Wings (Plate 1, fig. 6) pale yellow, the prearcular region clearer yellow; cells C and Sc light brown; a heavy darker brown seamed pattern, as follows: Arcular region, origin of Rs, cord and outer end of cell 1st M_2, stigma, and a narrow darkened apical and posterior border; veins brownish black, the prearcular veins yellow. Venation: Sc_1 ending some distance beyond fork of Rs, Sc_2 far before its tip; Rs strongly arcuated; free tip of Sc_2 just before level of R_2; cell 1st M_2 long, m longer and more arcuated than the basal section of M_3; m-cu before fork of M, subequal to or slightly longer than the distal section of Cu_1; anal veins at bases parallel or slightly divergent.

Abdomen pale yellow. Male hypopygium (Plate 2, fig. 30) with the tergite, 9*t*, deeply notched, the lateral lobes with conspicuous marginal setæ, the outermost larger and coarser. Ventral dististyle, *vd*, large and fleshy; rostrum slender, with two unequal spines, the outer stouter and bent before tip. Gonapo-

physes and basistyles damaged. Ovipositor with cerci slender, gently upcurved to the simple tips.

LUZON, Mountain Province, Benguet, Haight's Place, Pauai, altitude 8,000 feet (*Clagg and Rivera*); holotype, male, October 2, 1931; allotype, female, October 6, 1931; paratype, sex?; Bontoc, Mount Data, altitude 6,000 feet, October 8, 1931 (*Clagg and Rivera*); paratype, a teneral male.

By Edwards's key to the species of the subgenus [3] the present fly runs to couplet 58, disagreeing with both included species in the conspicuous wing pattern. Superficially it is much like *Limonia* (*Libnotes*) *perrara* Alexander, likewise from Pauai, which belongs to an entirely different group of the subgenus.

LIMONIA (DICRANOMYIA) SORDIDA BREVICULA subsp. nov.

Closely similar to typical *sordida* (Brunetti), differing especially in the much shorter rostral spines of the male hypopygium. These spines are about one-third the diameter of the rostrum at point of their insertion and are shorter than the longest setæ at apex of the prolongation. In *sordida* the spines are about as long as one-half the diameter of the prolongation and distinctly longer than the setæ.

LUZON, Mountain Province, Benguet, Haight's Place, Pauai, altitude 8,000 feet, October 6, 1931 (*Clagg and Rivera*); holotype, male, allotype, female, paratypes, males and females, October 5 and 6, 1931.

HELIUS (RHAMPHOLIMNOBIA) BREVINASUS sp. nov. Plate 1, fig. 7.

General coloration dark brown; rostrum relatively short, black throughout; knobs of halteres infuscated; wings whitish subhyaline, with a conspicuous brown pattern that is not reticulate; inner end of cell 1st M_2 strongly arcuated and pointed; abdominal sternites ringed caudally with silvery.

Female.—Length, excluding rostrum, about 6.5 millimeters; wing, 5; rostrum, 0.7.

Rostrum much shorter than in the subgenotype, *reticularis*, black throughout; palpi brown. Antennæ brownish black, the scape and pedicel somewhat more intense. Anterior vertex silvery gray, posterior vertex blackish.

Cervical region and pronotum blackish. Mesonotum chiefly dark brown, the præscutum vaguely more yellowish sublaterally

[3] Loc. cit.

and in the humeral region; median region of scutum somewhat brightened. Pleura brownish black, with indications of a narrow paler stripe on dorsal sternopleurite; pleurotergite somewhat paler, more obscure brownish yellow. Halteres pale, the knobs infuscated. Legs with the coxæ and trochanters blackened; remainder of legs broken. Wings (Plate 1, fig. 7) whitish subhyaline, with cells C and Sc more yellowish; a relatively restricted but conspicuous dark brown pattern that is confined to the vicinity of the veins, as follows: Arculus; origin of Rs; along cord and m; stigmal area, this latter confluent with a cloud at fork of Rs; darkened clouds at end of vein R_3 and near wing apex in outer end of cell R_3; paler marginal clouds at ends of veins Cu_1 and 2d A; a very narrow and indistinct brown seaming from wing tip back along margin to vein M_4; axillary region clouded; veins dark brown. Venation: r-m nearly its own length before fork of Rs; branches of Rs strongly divergent; inner end of cell 1st M_2 strongly arcuated and pointed; m-cu before fork of M.

Abdominal tergites blackened; a silvery area on intermediate pleural rings opposite posterior half of tergites; sternites brown, darker laterally, the posterior borders narrowly and conspicuously silvery. Ovipositor with the elongate valves yellowish horn color.

MINDANAO, Davao district, Tagum, Madaum River, March 27, 1931, at trap lantern (*Clagg*); holotype, female.

Helius (*Rhampholimnobia*) *brevinasus* is readily told from *H.* (*R.*) *reticularis* (Alexander) by the short rostrum and nonreticulated wing pattern.

LECHRIINI

TRICHONEURA (XIPHOLIMNOBIA) BONTOCENSIS sp. nov. Plate 1, fig. 8; Plate 2, fig. 31.

General coloration light to dark brown, the pleura pruinose; antennæ and legs black; wings suffused with brownish; Rs about one-fifth longer than R; male hypopygium with the tergite profoundly split medially; longest dististyle biramous, one arm terminating in a powerful fasciculate seta, the other in numerous small spines.

Male.—Length, about 2.5 to 3 millimeters; wing, 3 to 3.8.

Rostrum and palpi black. Antennæ black; flagellar segments elongate oval. Head dark gray.

Mesonotum dark brown, the pleura heavily pruinose with gray. Halteres dusky, the base of stem narrowly brightened.

Legs with the coxæ and trochanters brownish testaceous; remainder of legs brownish black to black. Wings (Plate 1, fig. 8) suffused with brownish; stigmal region not or scarcely darker; veins darker brown. Venation: Sc_1 ending about opposite four-fifths the length of Rs, the latter only about one-fifth longer than R; m-cu shortly beyond midlength of cell 1st M_2.

Abdomen brownish black; hypopygium obscure yellow. Male hypopygium (Plate 2, fig. 31) with the tergite, 9*t*, having a deep median notch, the truncated lobes without setæ. Dististyle, *d*, terminal including three distinct styli or branches; a short fingerlike lobe that is densely set with stout setæ and more delicate setulæ throughout its length; a slightly more elongate and more slender fingerlike lobe that bears two long setæ at and just before tip, the latter produced beyond the point of insertion of outer seta as a slender point; largest style a powerful arm that is two-branched at apex, one arm smooth, its truncated end further produced into a powerful curved fasciculate seta, the second arm more slender and slightly more elongate, set with numerous spinous points.

LUZON, Mountain Province, Bontoc, Kabunagan, October 11, 1931 (*Rivera*); holotype, male: Tayabas Province, Candelaria, near a small stream, June 25, 1930 (*McGregor and Rivera*); paratypes, 3 males.

The paratypes are much paler than the type, as described, but from the venation and structure of the male hypopygium, are conspecific.

The two known genera of the Lechriini may be separated as follows:

1. Cell 1st M_2 elongate, the basal section of M_{1+2} subequal in length to Rs; r-m placed about its own length before fork of Rs..... *Lechria* Skuse.
   Cell 1st M_2 of normal size, the basal section of M_{1+2} less than one-third the length of the long Rs; r-m normally placed, on R_{4+5} shortly beyond the origin of the latter ..... *Trichoneura* Loew.

Both of the known genera have now been discovered in the Philippines. The two described species of *Lechria* in the Islands have been figured by the writer in an earlier part of this series of papers.[4]

The genus *Trichoneura* is of great interest in that it is one of two genera of Tipulidæ that was first described as a fossil genus and was later found to have living relatives in various

[4] Philip. Journ. Sci. 40 (1929) 261–262, pl. 1, figs. 11, 12.

parts of the Old World. I would recognize three subgenera, which may be separated by the following key:

1. Tibial spurs present (fossil; Baltic Amber, Lower Oligocene). *Trichoneura* Loew.
   Tibial spurs lacking ..... 2.
2. Vertex bearing a small pale lobe or cornicle; wings patterned (Ethiopian) ..... *Ceratolimnobia* Alexander.
   Vertex unarmed; wings unmarked (Ethiopian, Oriental). *Xipholimnobia* Alexander.

The first recent species of *Trichoneura* to be made known was described as *Lechria nepalensis* Brunetti, from Katmandu, Nepal.[5] No mention is made of the presence of tibial spurs and I believe the fly would pertain to *Xipholimnobia*, as above defined. The second *Xipholimnobia* to be described was *T.* (*X.*) *formosensis* (Alexander),[6] from Kanshirei, northern Formosa. The three species of the subgenus in eastern Asia may be separated by the following key:

1. Legs pale yellowish (Nepal) ..... *nepalensis* (Brunetti).
   Legs brown or black ..... 2.
2. Rs unusually long, being more than one-half longer than R alone (Formosa) ..... *formosensis* (Alexander).
   Rs shorter, being approximately one-fifth longer than R (Luzon). *bontocensis* sp. nov.

References to the various subgenera and discussion of the position of *Trichoneura* in the tribe Lechriini may be found in two of my papers, in addition to those above cited.[7]

HEXATOMINI

TROGLOPHILA COTABATOENSIS sp. nov. Plate 1, fig. 9.

General coloration of thorax pale brown; antennæ with scape and pedicel light yellow, flagellum black; flagellar segments (male) elongate, weakly trinodose; legs brownish black; wings whitish subhyaline; Sc very long, Sc_1 ending nearly opposite the outer end of cell 1st M_2; R_3 running very close to R_{1+2}, cell R_2 at base narrow, vein R_2 short; cell 1st M_2 small, vein M_{3+4} only about one-half as long as vein M_4 beyond it.

Male.—Length, about 3.8 millimeters; wing, 4.8; antenna, about 5.3.

[5] Brunetti, Rec. Indian Mus. 15 (1918) 317–318; Edwards, Rec. Indian Mus. 26 (1924) 301.

[6] Philip. Journ. Sci. 22 (1923) 473–474.

[7] Proc. Linn. Soc. New South Wales 52 (1927) 54–55; Crane-flies of the Baltic Amber (Diptera), Bernstein-Forschungen (Amber Studies) 2 (1931) 54–57, figs. 62–67.

Rostrum yellow; palpi brown. Antennæ with scape and pedicel light yellow, flagellum black; in male, antennæ exceeding the wing in length, as shown by the measurements; flagellar segments elongate-cylindrical to feebly trinodose, with long outspreading setæ at the nodes, these setæ subequal in length to the segments. Eyes very large, reducing the anterior vertex to a linear strip, the inner margin opposite the antennal fossæ conspicuously emarginate. Front light yellow; vertex dark gray.

Thorax uniformly pale brown, the sternopleurite clearer yellow. Halteres chiefly pale. Legs with the coxæ and trochanters yellowish testaceous; remainder of legs brownish black, the femoral bases restrictedly obscure yellow. Wings (Plate 1, fig. 9) whitish subhyaline, the veins and very long macrotrichia dark brown. Venation: Sc of unusual length for a member of this genus, Sc_1 extending to nearly opposite the outer end of cell 1st M_2, Sc_2 a short distance from its tip; Rs arcuated, much shorter than the petiole of cell R_3; vein R_3 running very close to R_{1+2}, narrowing cell R_2 on its basal portion, vein R_2 being very short; cell 1st M_2 small, the veins issuing from it correspondingly lengthened; M_{3+4} about one-half of M_4 alone; m longer than basal section of M_3 m-cu at fork of M; anterior arculus present.

Abdominal tergites and hypopygium dark brown; basal sternites yellow.

MINDANAO, Cotabato Province, Mount Matutum, April 29, 1932 (*Rivera*); holotype, male.

The nearest allies of the present fly are *Troglophila alticola* (Edwards), of Borneo, and *T. ritozanensis* Alexander, of Formosa. The present fly differs especially in the clear wings, with the venational details quite distinct, especially the long Sc, position of vein R_3, and the relative length of the veins issuing from cell 1st M_2.

ERIOPTERINI

Genus TRENTEPOHLIA Bigot

Trentepohlia BIGOT, Ann. Soc. Ent. France III 2 (1854) 473.

The last general key to the Philippine species of *Trentepohlia* was one prepared by the writer [8] and included a total of fifteen species. Since the number of known species for the Islands has now doubled, it seems advisable to prepare a revised key to the species of this difficult genus.

[8] Philip. Journ. Sci. 43 (1930) 297–298.

Key to the Philippine species of Trentepohlia Bigot.

1. Wings with vein R_3 completely atrophied ..... 2.
   Wings with vein R_3 preserved ..... 4.
2. Wings with cell 1st M_2 closed; three outer medial veins, M_{1+2}, M_3, and M_4 (not yet recorded from the Philippines; known from Borneo and Sumatra) ..... Subgenus *Plesiomongoma* Brunetti.
   Wings with cell 1st M_2 open by the atrophy of m and the two distal sections of M_3; two outer medial veins, M_{1+2} and M_4.
   Subgenus *Anchimongoma* Brunetti 3.

Subgenus *Anchimongoma* Brunetti

3. Legs with the genua white, the color involving the femoral tips and tibial bases (Mindanao) ..... *apoicola* Alexander.
   Legs with the femora and tibiæ uniformly darkened (Mindanao). *beata* Alexander.
4. Wings with veins Cu_1 and 1st A fused for a distance back from the margin; cell 1st M_2 open or closed; if the latter, with three outer medial veins, M_{1+2}, M_3, and M_4 ..... 7.
   Wings with veins Cu_1 and 1st A entirely separate at margin; cell 1st M_2 closed, two outer medial veins, M_{1+2} and M_4.
   Subgenus *Paramongoma* Brunetti 5.

Subgenus *Paramongoma* Brunetti

5. Tibiæ white (Mindanao) ..... *chionopoda* Alexander.
   Tibiæ dark brown to black ..... 6.
6. Tips of femora narrowly but conspicuously whitened (Luzon). *banahaoensis* Alexander.
   Femora with tips uniformly darkened (Mindanao; Sunda Islands). *pusilla* Edwards.
7. Wings with cell 1st M_2 closed; three outer medial veins, M_{1+2}, M_3, and M_4 ..... Subgenus *Mongoma* Westwood 8.
   Wings with cell 1st M_2 open by the atrophy of m and the two distal sections of M_3; the outer medial veins, M_{1+2} and M_4.
   Subgenus *Trentepohlia* Bigot 26.

Subgenus *Mongoma* Westwood

8. Tips of femora abruptly and conspicuously white, the genua thus brightened ..... 9.
   Femora either uniformly darkened, or uniformly pale, or pale with the tips narrowly blackened, the genua not at all brightened ..... 13.
9. Crossvein m-cu at or beyond midlength of cell 1st M_2 (Luzon). *duyagi* Alexander.
   Crossvein m-cu at or before the fork of M ..... 10.
10. R_3 strongly arcuated, subperpendicular at origin, cell R_3 thus widened at base (Luzon) ..... *saxatilis* Alexander.
    R_3 not so strongly arcuated at origin, diverging gradually from R_4, cell R_3 not conspicuously widened at base ..... 11.

11. Mesonotal præscutum orange fulvous, narrowly darkened laterally (Mindanao) ..... *æquialba* Alexander.
Mesonotal præscutum dark brown ..... 12.
12. Wings with cells C and Sc undarkened, similar in coloration to remainder of wing; tibiæ uniformly pale (Luzon, Negros, Mindanao). *tenera* (Osten Sacken).
Wings with cells C and Sc strongly infumed, darker than remainder of wing; tibiæ brown, the tips whitened (Mindanao). *teneroides* Alexander.
13. Mid-tibiæ with distal ends white, conspicuously feathered with long outspreading white setæ (Luzon, Leyte, Negros, Mindanao; Austromalayan) ..... *pennipes* (Osten Sacken).
Mid-tibiæ normal, similar to other tibiæ ..... 14.
14. At least the fore tibiæ either uniform in color throughout their length, pale or dark, or else pale with the tips black ..... 15.
All tibiæ with the tips whitened (Mindanao). *alboterminalis* Alexander.
15. At least the fore tibiæ pale, with the tips abruptly blackened ..... 16.
Tibiæ uniform in color, either dark or pale throughout ..... 19.
16. Tibiæ of all legs approximately alike in color ..... 17.
Tips of fore tibiæ abruptly black, of the posterior tibiæ even more broadly snowy white (Luzon) ..... *luzonensis* Edwards.
17. Tibiæ and basitarsi yellow, their extreme bases, as well as their tips, blackened; m-cu about one-half its length beyond the fork of M (Luzon) ..... *ricardi* Alexander.
Tibiæ and basitarsi not abruptly blackened at bases; m-cu at or before the fork of M ..... 18.
18. Mesonotal præscutum polished black, the humeral region yellow; a dark area on anepisternum; abdominal tergites blackened (Mindanao). *æquinigra* Alexander.
Mesonotal præscutum yellow, in cases restrictedly darkened at suture; pleura uniformly pale; abdominal tergites yellow, with a narrow, more or less interrupted dorsomedian dark stripe (Mindanao). *majuscula* Alexander.
19. General coloration of body, legs, and wings pale yellow (Luzon, Mindanao; northern Australia) ..... *poliocephala* Alexander.
General coloration of body, legs, and wings not pale yellow ..... 20.
20. Mesonotal præscutum light yellow, with a median black line that broadens out behind (Luzon) ..... *lætithorax* sp. nov.
Mesonotal præscutum not colored as above ..... 21.
21. Wings with m-cu at or beyond one-third the length of cell 1st M_2 (Mindanao) ..... *distalis* Alexander.
Wings with m-cu at or before the fork of M ..... 22.
22. Wings conspicuously patterned with brown, including broad seams on Rs and posterior cord; tarsi black (Mindanao) .... *carbonipes* sp. nov.
Wings immaculate, except for the more or less distinct stigmal darkening; tarsi paling to yellow or whitish ..... 23.

23. Wings with cell R_5 longer than M_3; fusion between veins R_5 and M_{1+2} relatively short, less than the second section of vein M_{1+2} ..... 24.
Wings with cells R_5 and M_3 subequal; fusion of veins R_5 and M_{1+2} long, exceeding twice the second section of M_{1+2} ..... 25.
24. Mesonotum yellowish brown, somewhat darker medially; pleura obscure yellow, the dorsal portions dark brown; apical fusion of veins Cu_1 and 1st A conspicuous (Luzon) ..... *brevifusa* Alexander.
Mesonotum uniformly dark brown, the ventral pleurites paler; apical fusion of veins Cu_1 and 1st A very slight to almost lacking (Mindanao) ..... *persimilis* Alexander.
25. Mesonotal præscutum uniformly dark brown; cells C and Sc infumed, darker than the remainder of wing; cell R_2 at margin wide, exceeding one-half that of cell R_3 (Luzon) ..... *riverai* Alexander.
Mesonotal præscutum light fulvous yellow; cells C and Sc pale yellow, not infumed; cell R_2 at margin narrower, less than one-third cell R_3 (Mindanao) ..... *fulvinota* Alexander.

Subgenus *Trentepohlia* Bigot

26. Tips of femora abruptly whitened (Luzon) ..... *bakeri* Alexander.
Femora either uniformly pale in color, or pale with the tips narrowly blackened ..... 27.
27. Tips of femora and tibiæ conspicuously blackened; wings yellow, unmarked except for a narrow seam on vein R_3 (Luzon; Borneo, Java, Sumatra) ..... *mcgregori* Alexander.
Femora uniformly pale in color; wings not patterned as above ..... 28.
28. Wings almost immaculate, the costal border broadly suffused with yellow (Sibuyan) ..... *holoxantha* Alexander.
Wings with a conspicuous brown pattern ..... 29.
29. Abdomen entirely black (Luzon, Negros, Mindanao; Austromalayan). *pictipennis* Bezzi.
Abdomen with basal segments reddish, the terminal segments blackened. 30.
30. Wings heavily patterned with brown, the entire cephalic half infuscated, variegated only by four or five small white areas, the last one of which is at apex; wing base conspicuously dark brown (Mindanao). *lætipennis* Alexander.
Wings with entire costal border pale yellow, the tip abruptly darkened, without pale spot; no darkening at wing base (Luzon, Negros, Mindanao; Oriental, Austromalayan) ..... *trentepohlii* (Wiedemann).

The species of *Trentepohlia*, as they are now known from the Philippines, with references to their occurrence in the Islands, are as follows:

Trentepohlia (*Anchimongoma*) *apoicola* Alexander; ALEXANDER, Philippines, XII, Philip. Journ. Sci. 46 (1931) 475–476, pl. 1, fig. 22.
Trentepohlia (*Anchimongoma*) *beata* Alexander; ALEXANDER, Philippines, XIV, Philip. Journ. Sci. 48 (1932) 46–47, pl. 1, fig. 22.
Trentepohlia (*Paramongoma*) *banahaoensis* Alexander; ALEXANDER, Philippines, VI, Philip. Journ. Sci. 41 (1930) 308–309, pl. 1, fig. 15.
Trentepohlia (*Paramongoma*) *chionopoda* Alexander; ALEXANDER, Philippines, XII, Philip. Journ. Sci. 46 (1931) 469–470.

Trentepohlia (*Paramongoma*) *pusilla* Edwards; EDWARDS, Treubia **9** (1927) 356; ALEXANDER, Philippines, XII, Philip. Journ. Sci. **46** (1931) 470.

Trentepohlia (*Mongoma*) *æquialba* Alexander; ALEXANDER, Philippines, XII, Philip. Journ. Sci. **46** (1931) 470–471, pl. 1, fig. 18.

Trentepohlia (*Mongoma*) *æquinigra* Alexander; ALEXANDER, Philippines, XII, Philip. Journ. Sci. **46** (1931) 472–473, pl. 1, fig. 19.

Trentepohlia (*Mongoma*) *alboterminalis* Alexander; ALEXANDER, Philippines, XIV, Philip. Journ. Sci. **48** (1932) 46, pl. 1, fig. 21.

Trentepohlia (*Mongoma*) *brevifusa* Alexander; ALEXANDER, Philippines, VII, Philip. Journ. Sci. **43** (1930) 300–301, pl. 1, fig. 18.

Trentepohlia (*Mongoma*) *carbonipes* sp. nov.; this report.

Trentepohlia (*Mongoma*) *distalis* Alexander; ALEXANDER, Philippines, XI, Philip. Journ. Sci. **46** (1931) 284–285, pl. 1, fig. 15.

Trentepohlia (*Mongoma*) *duyagi* Alexander; ALEXANDER, Philippines, VII, Philip. Journ. Sci. **43** (1930) 298–299, pl. 1, fig. 16.

Trentepohlia (*Mongoma*) *fulvinota* Alexander; ALEXANDER, Philippines, XVI, Philip. Journ. Sci. **49** (1932) 272–273, pl. 1, fig. 21.

Trentepohlia (*Mongoma*) *lætithorax* sp. nov.; this report.

Trentepohlia (*Mongoma*) *luzonensis* Edwards; EDWARDS, Notulæ Entomologicæ **6** (1926) 37–38; ALEXANDER, Philippines, V, Philip. Journ. Sci. **40** (1929) 265–266, pl. 1, fig. 13.

Trentepohlia (*Mongoma*) *majuscula* Alexander; ALEXANDER, Philippines, XII, Philip. Journ. Sci. **46** (1931) 473–474, pl. 1, fig. 20.

Trentepohlia (*Mongoma*) *pennipes* (Osten Sacken); OSTEN SACKEN, Berlin. Ent. Zeitschr. **31** (1887) 204; BEZZI, Philip. Journ. Sci. § D **12** (1917) 115; EDWARDS, Notulæ Entomologicæ **6** (1926) 37; ALEXANDER, Philippines, IV, Philip. Journ. Sci. **33** (1927) 303.

Trentepohlia (*Mongoma*) *persimilis* Alexander; ALEXANDER, Philippines, XIV, Philip. Journ. Sci. **48** (1932) 45–46.

Trentepohlia (*Mongoma*) *poliocephala* Alexander; ALEXANDER, Philippines, V, VI, Philip. Journ. Sci. **40** (1929) 266–267, pl. 1, fig. 14; **41** (1930) 310–311.

Trentepohlia (*Mongoma*) *ricardi* Alexander; ALEXANDER, Philippines, VI, Philip. Journ. Sci. **41** (1930) 309–310, pl. 1, fig. 16.

Trentepohlia (*Mongoma*) *riverai* Alexander; ALEXANDER, Philippines, VII, Philip. Journ. Sci. **43** (1930) 299–300, pl. 1, fig. 17.

Trentepohlia (*Mongoma*) *saxatilis* Alexander; ALEXANDER, Philippines, V, Philip. Journ. Sci. **40** (1929) 267–269, pl. 1, fig. 15.

Trentepohlia (*Mongoma*) *tenera* (Osten Sacken); OSTEN SACKEN, Berlin. Ent. Zeitschr. **26** (1882) 89; ALEXANDER, Philippines, IV, Philip. Journ. Sci. **33** (1927) 302–303.

Trentepohlia (*Mongoma*) *teneroides* Alexander; ALEXANDER, Philippines, XVI, Philip. Journ. Sci. **49** (1932) 273–274, pl. 1, fig. 22.

Trentepohlia (*Trentepohlia*) *bakeri* Alexander; ALEXANDER, Philippines, IV, V, Philip. Journ. Sci. **33** (1927) 304–305, pl. 2, fig. 15; **40** (1929) 269.

Trentepohlia (*Trentepohlia*) *holoxantha* Alexander; ALEXANDER, Philippines, V, Philip. Journ. Sci. **40** (1929) 269–270, pl. 1, fig. 16.

Trentepohlia (*Trentepohlia*) *lætipennis* Alexander; ALEXANDER, Philippines, XII, Philip. Journ. Sci. **46** (1931) 474–475, pl. 1, fig. 21.

Trentepohlia (*Trentepohlia*) *mcgregori* Alexander; ALEXANDER, Philippines, IV, Philip. Journ. Sci. 33 (1927) 303–304, pl. 2, fig. 12.

Trentepohlia (*Trentepohlia*) *pictipennis* Bezzi; BEZZI, Philip. Journ. Sci. § D 12 (1917) 115; EDWARDS, Notulæ Entomologicæ 6 (1926) 37.

Trentepohlia (*Trentepohlia*) *trentepohlii* (Wiedemann); WIEDEMANN, Aussereur. zweifl. Ins. 1 (1828) 551; ALEXANDER, Philippines, IV, Philip. Journ. Sci. 22 (1927) 303.

The roman numerals with the various Alexander references given above refer to the various parts of the Philippine series of papers.

TRENTEPOHLIA (MONGOMA) CARBONIPES sp. nov. Plate 1, fig. 10.

Mesonotal præscutum light fulvous brown, the mediotergite and pleura abruptly dark brown; legs black, the femoral bases restrictedly yellow; wings tinged with grayish brown, cells C and Sc more brownish yellow; stigma and conspicuous seams on certain veins brown; wing apex slightly darkened; less distinct brown seams on outer end of cell 1st M_2; Rs short, subequal to basal section of R_5 and the cephalic face of cell 1st M_2.

Female.—Length, about 8 millimeters; wing, 8.3.

Rostrum testaceous; palpi dark brown. Antennæ brownish black throughout; flagellar segments cylindrical, with very short verticils. Head dark.

Pronotum and mesonotal præscutum light fulvous brown; scutal lobes dark brown; scutellum obscure yellow, the center of disk at base dark brown; mediotergite dark brown. Pleura uniformly dark brown, only the meral region paler. Halteres infuscated, the base of stem restrictedly yellow. Legs with the coxæ brownish; trochanters yellow; remainder of legs black, only with the femoral bases very restrictedly yellowish; legs without specially modified spines or setæ. Wings (Plate 1, fig. 10) tinged with grayish brown; cells C and Sc, together with the abbreviated prearcular region, more brownish yellow; stigma triangular, dark brown; certain veins with conspicuous brown seams, as follows: Arcular and axillary regions, Rs and posterior cord, radial veins beyond stigma; wing apex darkened; less distinct brown seams on outer end of cell 1st M_2. Venation: Rs short, subequal to basal section of R_5 and the cephalic face of cell 1st M_2 ($R_5 + M_{1+2}$); R_2 just before base of cell R_3; inner ends of cells R_5 and M_3 about in transverse alignment; m-cu at fork of M; apical fusion of veins Cu_1 and 1st A slight.

Abdominal segments indistinctly bicolorous, dark brown, the bases of the segments slightly paler.

MINDANAO, Cotabato Province, Mount Matutum, April 12, 1932 (*Rivera*); holotype, female.

Trentepohlia (*Mongoma*) *carbonipes* is abundantly different from all other Philippine species of the subgenus in the black legs and conspicuously patterned wings. By Edwards's synopsis of the Oriental and Australasian species of *Mongoma*[9] the fly runs to *T.* (*M.*) *sarawakensis* Edwards (Borneo), a very different fly that has the femoral tips pale and the thorax uniformly brownish ocherous.

TRENTEPOHLIA (MONGOMA) LÆTITHORAX sp. nov. Plate 1, fig. 11.

Mesonotal præscutum light yellow, with a conspicuous black median line that widens behind; posterior portion of mediotergite obscure yellow; dorsal pleurites black, the sternopleurite yellow; legs light brown; wings grayish subhyaline, the outer costal region and stigma brown; cell R_2 at wing margin narrower than at base; proximal end of cell M_3 lying proximad of cell R_5; abdomen black.

Male.—Length, about 5.5 millimeters; wing, 6.

Female.—Length, about 6 millimeters; wing, 6.

Rostrum, palpi, and antennæ black; flagellar segments of latter long-oval, with short verticils. Head dark gray.

Mesonotal præscutum clear yellow, with a very conspicuous median black line, narrowest in front, behind the level of the pseudosutural foveæ widened out, crossing the suture and including all of the scutum except the cephalic-lateral portions of the scutal lobes, which are light yellow; region of pseudosutural foveæ and extreme lateral margin of præscutum narrowly infuscated; scutellum black; mediotergite with slightly more than the cephalic half black, the posterior portion obscure yellow, divided by a capillary black median vitta. Pleura with the dorsal sclerites blackened, the sternopleurite yellow. Halteres faintly tinged with dusky, especially the knobs. Legs with the coxæ testaceous yellow, the fore coxæ and bases of mid-coxæ slightly more infumed; trochanters yellow; remainder of legs almost uniformly light brown; fore femora with a series of from six to eight strong bristles near base. Wings (Plate 1, fig. 11) grayish subhyaline, the outer costal region and stigma brown; wing apex narrowly and insensibly infumed; veins dark brown. Venation: R_3 diverging strongly from R_4, cell R_2 at margin narrower than at proximal end; proximal end of cell M_3 lying basad of that of

[9] Journ. Fed. Malay States Mus. 14 (1928) 110–111.

cell R_5; apical fusion of veins Cu_1 and 1st A slight; cell 2d A wide.

Abdomen, including hypopygium, black.

LUZON, Tayabas Province, Lucban (*Rivera*); holotype, male, January 25, 1931; allotype, female, January 22, 1931; paratype, female, January 26, 1931.

GONOMYIA (PTILOSTENA) COTABATOENSIS sp. nov. Plate 1, fig. 12; Plate 2, fig. 32.

Thoracic dorsum chiefly dark brown; basal two segments of antennæ more or less yellow; legs yellow, the tips of tibiæ and outer tarsal segments darkened; wings tinged with yellow, unmarked except for the small brown stigma; veins R_{1+2} and R_3 contiguous at margin; male hypopygium with the inner dististyle terminating in two powerful blackened spikelike points, directed laterad at a right angle to apex of lobe; ædeagus entirely pale, the slightly expanded outer end with abundant black setulæ.

Male.—Length, about 4.5 millimeters; wing, 4.2.

Female.—Length, about 5.5 millimeters; wing, 4.8.

Rostrum and palpi black. Antennæ with scape dark beneath, lined with yellow above; pedicel chiefly light yellow; flagellum brownish black throughout; flagellar segments fusiform, with long conspicuous verticils. Head obscure brownish yellow, the center of vertex dusky.

Pronotum and anterior lateral pretergites light yellow. Mesonotal præscutum chiefly dark brown, with a median plumbeous gray stripe, the lateral borders pale yellow; posterior sclerites of notum chiefly dark brown, the posterior border of scutellum broadly obscure yellow. Pleura almost uniformly pale brown, the dorsal sclerites darker. Halteres dusky. Legs with the coxæ and trochanters yellowish testaceous; remainder of legs light yellow, the tips of the tibiæ very narrowly but conspicuously brownish black; tarsi blackened. Wings (Plate 1, fig. 12) tinged with yellow, the costal region clear light yellow; stigma small, subcircular, dark brown; veins pale brown, the extreme base of Rs and the cord darker brown; veins C and Sc more yellowish. Venation: Sc_1 ending about opposite one-third the length of the strongly arcuated Rs; distal end of R_1 running very close to costa, at tip confluent with R_3; m-cu about one and one-half times its length before the fork of M.

Abdominal tergites weakly bicolorous, the basal portions on sides obscure yellow, the caudal portions dark brown, more or less distinctly divided medially by a pale line; sternites clear light yellow. Male hypopygium (Plate 2, fig. 32) with the inner dis-

tistyle, *id*, blackened at tip and produced laterad into two strong spikelike spines, with a smaller erect black spine at apex. Outer style, *od*, a long pale sinuous rod. Branches of intermediate style blackened along margin. There is evidently still another branch or style, partly broken in the type, here represented by a broad, pale flattened blade. Ædeagus, *a*, slender at base, a little expanded toward apex, entirely pale; outer expanded portion set with abundant microscopic setulæ.

MINDANAO, Cotabato Province, Makar, Nupol, March 30, 1932 (*Rivera*); holotype, male; Covell, Buayan, March 25, 1932 (*Rivera*); allotype, female; Mount Matutum, April 9, 1932 (*Rivera*); paratype, male.

Gonomyia (*Ptilostena*) *cotabatoensis* is very different from the two species of the subgenus hitherto reported from the Philippines (*metatarsata* de Meijere and *punctipennis* Edwards), differing from the former in the uniformly pale yellow femora, and from the latter in the unspotted wings and very different structure of the male hypopygium. It is also quite distinct from the far more numerous species of the subgenus now known from Japan, Formosa, and eastern China.

GONOMYIA (PTILOSTENA) METATARSATA ATROPHIA subsp. nov. Plate 1, fig. 13.

Female.—Length, about 6 millimeters; wing, 5; foreleg, tibia, 4.6, basitarsus, 2.8.

Characters as in typical *metatarsata* de Meijere (India to Java), differing especially in the intense blackened tips of the femora and the partly atrophied vein R_4 of the wings.

Legs yellow, the tips of all femora narrowly but very conspicuously blackened; tibiæ similar, the tips more narrowly blackened. Wings (Plate 1, fig. 13) narrow; most of vein R_4 atrophied, in the type with only a basal spur that is a little longer than R_3, with three macrotrichia on spur; cell 2d A much wider than indicated by de Meijere's figure of the typical form.[10] Abdomen of type female uniformly blackened, only the genital region paler.

LUZON, Tayabas Province, Lucban, January 29, 1931 (*Rivera*); holotype, female.

The exact status of this fly is still in question. The partly atrophied condition of vein R_4 of the wings is apparently a normal one, inasmuch as it was reported also by Edwards in a male specimen from Dumaguete, Negros.[11]

[10] Tijd. voor Entom. 54 (1911) pl. 3, fig. 35.

[11] Notulæ Entomologicæ 6 (1926) 37, as *metatarsata*.

GONOMYIA (GONOMYIA) PAUAIENSIS sp. nov. Plate 1, fig. 14; Plate 2, fig. 33.

Belongs to the *subcinerea* group; mesonotum brownish black, the median area of scutum and the scutellum yellow; antennæ and legs black; wings faintly tinged with brown, the stigmal region darker; Sc_1 ending about opposite one-fifth the length of Rs; male hypopygium with the dististyle a flattened blade that bears a single powerful black spine on outer margin, the broad apex of style terminating in two setæ.

Male.—Length, about 4.5 millimeters; wing, 5.3.

Female.—Length, about 6 millimeters; wing, 5.8.

Rostrum brownish black; palpi black. Antennæ black throughout, relatively elongate, especially in female. Head dark gray, brighter on occiput.

Pronotum orange-yellow. Anterior lateral pretergites light yellow. Mesonotal præscutum brownish black, sparsely pruinose, the humeral region restrictedly brightened; scutal lobes black, the median region obscure yellow; separated from the deep yellow scutellum by a narrow blackish line crossing the posterior border; mediotergite black, pruinose. Pleura and pleurotergite almost entirely pale yellow, variegated by blackish gray on the anepisternum and sternopleurite. Halteres elongate, dusky, the base of stem yellow, the knobs obscure brownish yellow to pale brown. Legs with the coxæ brown, more or less yellow apically; trochanters brown; remainder of legs black. Wings (Plate 1, fig. 14) with a faint brown tinge, the stigmal region darker; veins brownish black. Costal fringe of male moderate in length. Venation: Sc_1 ending about opposite one-fifth the length of Rs, Sc_2 a short distance from its tip; m-cu at fork of M.

Abdominal tergites dark brown, sternites brownish yellow. Male hypopygium (Plate 2, fig. 33) with the tergite, 9*t*, deeply bilobed, each lobe with a lateral pencil of setæ. Shorter apical lobe of basistyle, *b*, relatively small, pale, with several elongate setæ that about equal the lobe in length; longer lobe of basistyle, *b*, fleshy, the apex a little dilated into a blade, the mesal edge of which is without setæ. Dististyle, *d*, with a powerful curved black spine on outer margin at near midlength, this with a single seta at near one-third the length; body of style terminating in two fasciculate setæ, the disk with about five setæ on one face and eight on the other. Ædeagus, *a*, subtended by two very unequal spines, the longest of which is blackened along edge, the short one a small pale spike.

LUZON, Mountain Province, Benguet, Haight's Place, Pauai, altitude 8,000 feet, October 6, 1931 (*Clagg and Rivera*); holotype, male; allotype, female.

Gonomyia (*Gonomyia*) *pauaiensis* is very similar to other species of the subgenus in Formosa and the Philippines, differing in the structure of the male hypopygium, especially the conformation of the dististyle. By my key to the Philippine species of *Gonomyia*[12] the fly runs to *G.* (*G.*) *nebulicola* Alexander (Mindanao), at that time the only member of the subgenus known from the Islands.

GONOMYIA (GONOMYIA) GRATILLA sp. nov. Plate 1, fig. 15; Plate 2, fig. 34.

Belongs to the *subcinerea* group; general coloration of mesonotum dark brown; pleura chiefly pale, the anepisternum darker; rostrum obscure yellow; legs brownish black; wings grayish subhyaline; stigma pale brown, faintly indicated; Sc_1 ending opposite origin of Rs; cell 1st M_2 narrow; male hypopygium with the dististyle bearing a small fingerlike lobe near base; outer portion of style narrowed to an acute black point, on outer face before tip with two strong fasciculate setæ; phallosome with ædeagus narrow; pale; two slender pale apophyses, one shorter and very acute.

Male.—Length, about 3 millimeters; wing, 3.5.

Rostrum obscure yellow, palpi black. Antennæ black; flagellar segments elongate, with abundant dense erect setæ. Head dark gray.

Anterior lateral pretergites obscure yellow. Mesonotal præscutum dark brown medially, somewhat paler on sides; median region of scutum obscure yellow; scutellum obscure yellowish testaceous; mediotergite brown. Pleura chiefly pale, the anepisternum darker. Halteres relatively elongate, dark brown, the base of stem pale. Legs with the coxæ obscure yellow, the fore coxæ darker; trochanters obscure yellow; remainder of legs brownish black. Wings (Plate 1, fig. 15) grayish subhyaline; stigma pale brown, faintly indicated; veins brown; macrotrichia long and abundant, black. Venation: Sc_1 ending opposite origin of Rs; r-m long, gently arcuated, placed at or just before fork of Rs, in alignment with R_5 the basal deflection of the latter obliterated; m-cu at fork of M; cell 1st M_2 narrow.

[12] Philip. Journ. Sci. 48 (1932) 615–617.

Abdomen dark brown; hypopygium obscure yellow. Male hypopygium (Plate 2, fig. 34) with the outer lobe of basistyle, *b*, a little expanded on mesal portion. Dististyle, *d*, with a slender fingerlike lobe near base, this tipped with a single strong seta; outer portion of style slender, blackened, narrowed to an acute point, before apex on outer face with two strong fasciculate setæ arising close together, the outermost only about two-thirds the length of the inner or lower seta. Phallosome, *p*, consisting of the unusually narrow, pale ædeagus, and two unequal pale apophyses, one shorter and much slenderer than the second, needlelike.

MINDANAO, Davao district, Tagum, Madaum River, at trap lantern, May 27, 1931 (*Clagg*); holotype, male; allotype, female; paratypes, females.

Gonomyia (*Gonomyia*) *gratilla* is very different from the other members of the group in the structure of the dististyle and the entirely pale phallosome. It is much smaller than all other Oriental members of the group, with the exception of *G.* (*G.*) *longifimbriata* sp. nov., which differs in the long costal fringe of the wings and in the structure of the male hypopygium.

GONOMYIA (GONOMYIA) LONGIFIMBRIATA sp. nov. Plate 1, fig. 16; Plate 2, fig. 35.

Belongs to the *subcinerea* group; size small (wing, male, 3.5 millimeters); general coloration of notum brown; pleura brown, the pteropleurite paler; legs black; wings with a faint gray tinge; costal fringe (male) very long and conspicuous; m-cu before fork of M; male hypopygium with the dististyle bearing a long slender outer lobe and a flattened inner blade that has two curved black spines.

Male.—Length, about 3 millimeters; wing, 3.5.

Rostrum and palpi brownish black. Antennæ black throughout; flagellar segments long-oval, with elongate verticils. Head dark.

Anterior lateral pretergites restrictedly pale yellow. Mesonotum uniformly brown. Pleura brown, the pteropleurite abruptly paler. Halteres broken. Legs with the coxæ and trochanters brownish testaceous; remainder of legs black. Wings (Plate 1, fig. 16) with a faint gray tinge; veins brown. Costal fringe (male) very long and conspicuous, only a little shorter, though stouter, than the posterior fringe. Venation: Sc ending just before the origin of Rs, Sc_2 a short distance beyond the end of Sc_1, immediately opposite origin of Rs; Rs in alignment with R_5, the basal section of the latter lacking; R_3 relatively short,

about one-third longer than distance on margin between tips of veins R_{1+2} and R_3; m-cu before fork of M.

Abdomen brownish black; hypopygium somewhat brighter. Male hypopygium (Plate 2, fig. 35) with the dististyle, *d*, divided into two parts, an outer slender fleshy arm, with long conspicuous setæ along its entire length; and a stouter blade that bears a powerful curved black spine on outer margin at near midlength; apex of lobe with a small, less curved, black spine, on apical margin below which are two powerful fasciculate setæ; face of lobe with a linear series of about six long setæ. Phallosome, *p*, with two slender arms at near midlength, both arms ending in slender spines .

MINDANAO, Cotabato Province, Cornadal, April 19, 1932 (*Rivera*); holotype, male.

The small size, long costal fringe of male, and construction of the male hypopygium readily separate the present fly from other Indo-Malayan species of the subgenus.

GONOMYIA (GONOMYIA) VERSICOLOR sp. nov. Plate 1, fig. 17.

Belongs to the *cognatella* group; general coloration of thoracic notum a medium brown; pleura striped longitudinally with whitish; knobs of halteres dusky; legs dark brown; wings brownish, the disk conspicuously variegated by subhyaline areas before and beyond cord; stigma dark brown; paler brown seams along cord; abdomen brownish black, the segments ringed caudally with whitish.

Female.—Length, about 3.3 to 3.8 millimeters; wing, 3.5 to 4.2.

Rostrum and palpi black. Antennæ with basal two segments yellow beneath, darker above; flagellum black. Head above chiefly pale, the center of vertex more or less darkened.

Anterior lateral pretergites and pronotum light yellow. Mesonotum almost uniform medium brown, the præscutum a little darker sublaterally; scutellum not brightened. Pleura dark brown, conspicuously striped longitudinally with a ventral whitish stripe extending from the fore coxæ to the base of abdomen, passing beneath the halteres. Halteres obscure whitish, the knobs dusky. Legs with the coxæ obscure testaceous, the fore coxæ white, as described; remainder of legs dark brown. Wings (Plate 1, fig. 17) with the ground color brownish, especially the apical region, the disk conspicuously variegated by extensive subhyaline areas before and beyond cord; stigma dark brown, very conspicuous; distinct but paler brown clouds along

cord and fork of M_{1+2}; veins pale brown, darker in the clouded areas. Venation: Sc_1 ending just beyond origin of Rs, Sc_2 at its tip; m-cu close to fork of M.

Abdominal segments brownish black, the caudal borders narrowly ringed with whitish. Ovipositor with genital shield blackened, the elongate valves brownish yellow.

MINDANAO, Davao district, Tagum, Madaum River, at trap lantern, March 27, 1931 (*Clagg*); holotype, female; paratype, female.

Gonomyia (*Gonomyia*) *versicolor* is closest to *G.* (*G.*) *obscuriclava* Alexander (Sumatra), differing in the details of coloration, most conspicuously in the highly variegated wing pattern of the present fly. Unfortunately the male of neither of these species is available for comparison.

GONOMYIA (LIPOPHLEPS) PERREDUCTA sp. nov. Plate 1, fig. 18; Plate 3, fig. 36.

Mesonotal præscutum brownish black medially, paler brown sublaterally, the borders yellow; knobs of halteres obscure yellow; legs black; wings with a pale brown tinge; cell R_3 present but very small; macrotrichia on nearly the whole length of both anal veins; male hypopygium large and very complex in structure, the inner dististyles of the two sides quite different in construction; outer lobe of basistyle of each side very long and fingerlike.

Male.—Length, about 3.5 millimeters; wing, 3.8 to 4.

Female.—Length, about 4.5 millimeters; wing, 4.5.

Rostrum dark brown; palpi black. Antennæ black throughout; flagellar segments of male with long conspicuous verticils on segments five to nine, inclusive, the other flagellar segments with shorter verticils; longest verticils approximately three times as long as the segments that bear them. Head blackened, the central portion of the occipital region brighter.

Pronotum and anterior lateral pretergites yellow. Mesonotal præscutum brownish black medially, paler brown away from the central area; humeral and lateral portions of præscutum obscure yellow; scutal lobes and a transverse area on posterior portion of median area of scutum dark brown; remainder of median area of scutum and the scutellum yellow; mediotergite yellow on cephalic half, more reddish on posterior portion. Pleura and pleurotergite yellow, the anepisternum and sternopleurite somewhat more infumed. Halteres with stem dusky, obscure yellow at base, the apices of the knobs light yellow. Legs with the fore coxæ darkened, the remaining coxæ and all trochanters yellow;

remainder of legs black, the femoral bases restrictedly pale. Wings (Plate 1, fig. 18) with a pale brown tinge, cells C and Sc pale yellow, the stigmal region darker brown, diffuse; veins and macrotrichia brown. Costal fringe moderately long and conspicuous; macrotrichia of veins conspicuous, none on R_3; both anal veins with trichia except at their bases. Venation: Sc_1 ending opposite origin of Rs or nearly so, Sc_2 close to its tip; vein R_3 present, oblique to suberect, cell R_2 at margin subequal to cell R_3; Rs shorter than petiole of cell R_3; m-cu close to fork of M.

Abdominal tergites chiefly brown, the caudal and lateral borders of the segments brightened; sternites chiefly light yellow. Male hypopygium (Plate 3, fig. 36) with the dististyle, *d*, and phallosome, *p*, highly asymmetrical, large and complex in structure. Basistyle, *b*, alike on both sides, the lobe very long, pale, cylindrical, clothed with long conspicuous setæ. Dististyle, *d*, of one side bearing two slender arms besides the fleshy innermost one that terminates in a single powerful fasciculate seta, and, in addition, bears the usual elongate seta on outer face at near two-thirds the length; longest arm of this style strongly curved and convoluted. Dististyle, *d*, of the opposite side bearing a single arm additional to the inner, fleshy, bristle-bearing arm, which is quite like its mate of the opposite side. Phallosome, *p*, consisting of three yellowish blades, of which one is much longer, compressed, hanging pendant from the genital chamber like a cleaver.

MINDANAO, Cotabato Province, Mount Matutum, April 9 to 27, 1932 (*Rivera*), holotype, male; allotype, female; paratypes, both sexes; Barrio Lagdaan, April 4, 1932 (*Rivera*); paratypes, both sexes; Nupol, April 2, 1932 (*Rivera*); paratypes, both sexes.

The other regional species of the subgenus having cell R_3 present (*nubeculosa* de Meijere and *pallidisignata* Alexander) have the wings conspicuously patterned with dark and light colors, and the femora conspicuously ringed with black before the tips. The present fly is very distinct from other Oriental species of *Gonomyia* in the unusually small cell R_3 and the large complex male hypopygium, with asymmetrical dististyles. By my key to the Philippine species of the genus,[13] the fly runs to *pallidisignata*.

[13] Philip. Journ. Sci. 48 (1932) 615–617.

GONOMYIA (LIPOPHLEPS) PINIVAGATA sp. nov. Plate 1, fig. 19; Plate 3, fig. 37.

Belongs to the *skusei* group; size large (wing, 5 millimeters or more); antennæ black throughout, in male, the flagellar segments long-cylindrical, with abundant outspreading erect setæ; pleura conspicuously striped longitudinally with white; wings with a strong brownish tinge; abdominal tergites dark brown, sternites yellow; male hypopygium with the dististyle single, entirely fleshy; phallosome terminating in four obtuse points, the surface with conspicuous erect setæ.

Male.—Length, about 4 to 4.2 millimeters; wing, 5 to 5.3.

Female.—Length, about 4.2 millimeters; wing, 5.

Rostrum brownish black, more obscure yellow on sides; palpi black. Antennæ black throughout; flagellar segments (male) long-cylindrical, with abundant outspreading erect setæ. Head gray.

Pronotum and anterior lateral pretergites whitish. Mesonotum dark brown or brownish black, the scutellum, broad median area of scutum, and posterior angles of scutal lobes yellow; mediotergite more pruinose, the cephalic-lateral portion and dorsal half of pleurotergite yellow. Pleura dark brown, with a conspicuous white longitudinal stripe extending from behind the fore coxæ to the base of abdomen. Halteres brown, the base of stem and apex of knob slightly brightened. Legs with the coxæ and trochanters dark; remainder of legs brownish black. Wings (Plate 1, fig. 19) with a strong brownish tinge, the stigmal region very vaguely darker; veins dark brown. Venation: Sc long, Sc_1 ending about opposite one-third to two-fifths the length of Rs, Sc_2 at near mid-distance between origin of Rs and tip of Sc_1; outer radial veins elongate; basal section of R_5 short; cell R_5 narrowed at margin; m-cu at or close to fork of M.

Abdominal tergites dark brown, sternites yellow. Male hypopygium (Plate 3, fig. 37) with a single fleshy dististyle, *d*, this subequal in length and size to the apical lobe of basistyle, *b*, terminating in a powerful fasciculate seta and with one unusually long seta on outer face at near two-thirds the length, in addition to the more normal setæ. Phallosome, *p*, with four obtuse points at apex, with two slender darkened rods or tubes extending almost the entire length of the structure; surface of phallosome with conspicuous scattered setæ.

LUZON, Mountain Province, Benguet, Haight's Place, Pauai, altitude 8,000 feet, in pine forest (*Pinus insularis* Endlicher) (*Clagg and Rivera*), October 5–6, 1931; holotype, male; allotype, female; paratypes, both sexes, October 2 to 6, 1931; Clark's

Place, Camp 66, altitude 7,000 feet, October 6, 1931 (*Clagg and Rivera*); paratypes, both sexes.

Gonomyia (*Lipophleps*) *pinivagata* is the largest species of the *skusei* group in the Oriental Region, being fully equal in size to the typical species, *G.* (*L.*) *skusei* Alexander, of eastern Australia. It is readily told from other allied species by the structure of the phallosome of the male hypopygium.

GONOMYIA (LIPOPHLEPS) RAMIFERA sp. nov. Plate 1, fig. 20; Plate 3, fig. 38.

Allied to *jacobsoniana;* male hypopygium with the middle dististyle biramous, both arms densely covered with conspicuous setæ; inner dististyle a long slender rod, hinged at base, the distal third with numerous scattered erect setæ.

Male.—Length, about 3.5 to 3.6 millimeters; wing, 2.9 to 3.2.

Female.—Length, about 3.8 to 4 millimeters; wing, 3.2 to 3.4.

Rostrum and palpi black. Antennæ with basal two segments dark above, yellow beneath; flagellum brownish black. Head light yellow, the posterior vertex extensively variegated with dark brown.

Pronotum and anterior lateral pretergites light yellow. Mesonotal præscutum and scutum brown, bordered laterally by a narrow, more blackish line; pseudosutural foveæ black; scutellum dark, broadly bordered by light yellow; mediotergite dark gray. Pleura dark gray, with a conspicuous whitish longitudinal stripe extending from fore coxæ to the base of abdomen. Halteres obscure yellow, the knobs dusky. Legs with the fore coxæ pale, remaining coxæ darkened; trochanters brownish yellow; femora brownish yellow, the fore and middle femora with black terminal rings, the posterior femora with these rings subterminal; dark femoral annuli preceded by a narrow, more yellowish annulus; tibiæ yellow, the extreme bases blackened, narrowest and least distinct on the posterior tibiæ; tips of tibiæ narrowly blackened; tarsi obscure yellow, the tips of basitarsi and second segment, and all of remaining segments darkened. Wings (Plate 1, fig. 20) grayish subhyaline, virtually immaculate, the stigma scarcely indicated; veins pale brown, the cord somewhat darker. Venation: Sc_1 ending just before origin of Rs; basal section of R_5 elongate; m-cu varying in position from close to fork of M to about two-thirds its length before this fork.

Abdominal tergites black, the caudal borders (male) narrowly obscure whitish; sternites uniformly blackened. Male hypopygium (Plate 3, fig. 38) with three dististyles, the innermost, *id*, basal, almost in the usual position of an interbase.

Outer dististyle, *od*, a simple curved glabrous rod. Middle style, *md*, shorter, biramous by a slender branch at near two-thirds the length, this set with short spinous setæ; main axis of style stouter, with long coarse setæ. Inner style, *id*, very long and slender, hinged at base, but not provided with setæ at this point as in *jacobsoniana;* outer third of style with scattered conspicuous setæ. Phallosome, *p*, and asymmetrical mass.

MINDANAO, Davao district, Tagum, Madaum River, at trap lantern, March 27, 1931 (*Clagg*); holotype, male; allotype, female; paratypes, several, both sexes.

The present fly is readily distinguished from the other described species that are allied to *Gonomyia* (*Lipophleps*) *diffusa* (de Meijere) by the structure of the male hypopygium, especially of the middle and inner dististyles.

GONOMYIA (LIPOPHLEPS) JACOBSONIANA Alexander.

Gonomyia (*Lipophleps*) *jacobsoniana* ALEXANDER, Philip. Journ. Sci. 53 (March, 1934).

MINDANAO, Davao district, Tagum, Madaum River, at trap lantern, March 26–27, 1931 (*Clagg*). Known elsewhere from Sumatra.

GONOMYIA (LIPOPHLEPS) LUTEIMARGINATA Alexander.

Gonomyia (*Lipophleps*) *luteimarginata* ALEXANDER, Philip. Journ. Sci. 46 (1931) 32–33.

Described from Calian, Lawa, Mindanao, and now known to be widely distributed in the Austromalayan islands.

LUZON, Manila, at lamp, August 5, 1932 (*McGregor*); 1 male. NORTH CELEBES, Roeroekan, Minahassa, altitude 4,000 feet, at light, April 14, 1931 (*Clagg*); 1 male. NEW GUINEA, Seleo, Berlinhafen, 1896 (*Biró*); 2 males.

Riedel [14] had earlier determined the two last-mentioned specimens as being *Lipophleps brevivena* Skuse (No. 25) and *L. nebulosa* de Meijere (?) (No. 27). The specimens are in the Hungarian National Museum and were examined by me through the kindness of Doctor Szilady.

GONOMYIA (LIPOPHLEPS) DIACANTHA sp. nov. Plate 3, fig. 39.

Allied to *luteimarginata;* general coloration dark grayish brown, the scutellum chiefly yellow; pleura blackish gray, with a broad whitish longitudinal stripe; legs brownish yellow to brown; wings variegated with pale brown and subhyaline areas, the costal region clear light yellow; Sc short; abdominal tergites

[14] Ann. Mus. Nat. Hungarici 18 (1920) 136.

uniformly dark brown; male hypopygium with both dististyles terminal in position, the outer bearing two black teeth or spines near base of mesal face.

Male.—Length, about 2.3 to 2.5 millimeters; wing, 2.8 to 3.1.

Female.—Length, about 2.8 to 3 millimeters; wing, 3.2 to 3.3.

Rostrum and palpi black. Antennæ black, the upper surface of the basal two segments obscure yellow. Head yellow, the center of vertex darkened.

Anterior lateral pretergites and lateral borders of præscutum pale yellowish white. Mesonotum dark grayish brown, the pseudosutural foveæ black; median region of scutum and posterior portions of lobes yellow; scutellum yellow, darkened medially at base; mediotergite chiefly darkened, yellow laterally, in cases with the yellow color continued subbasally across the sclerite. Pleura blackish, pruinose, with a broad whitish or yellowish white longitudinal stripe extending from the fore coxæ across the dorsal sternopleurite and meral region to the base of abdomen, passing beneath the halteres. Halteres dusky, the apex of knob obscure yellow. Legs with the coxæ dark, fore coxæ white, as described; trochanters obscure yellow; femora obscure brownish yellow to brown, deepening toward outer end; tibiæ and tarsi darkened. Wings clouded with pale brown and subhyaline areas, iridescent; cells C and Sc clear light yellow; stigma darker brown; subhyaline brightenings mostly before and beyond cord and in the outer ends of cubital and anal cells; veins pale, the cord and outer medial veins darker. Venation: Sc short, Sc_1 ending a distance before origin of Rs about equal to m-cu or two-thirds the length of Rs; veins of radial field strongly divergent; basal section of R_5 long; m-cu at fork of M.

Abdominal segments in both sexes uniform dark brown; sternites a very little paler; hypopygium orange. Male hypopygium (Plate 3, fig. 39) with the outer dististyle, *od,* bearing two teeth near base on mesal edge, the basal one longer and slenderer, the outer tooth separated from the first by a rounded or oval notch; remainder of style entire, blackened. Inner dististyle, *id,* shorter, strongly curved at near midlength, the apex narrowed into a slender black spine. Apical spines of gonapophyses long and slender, blackened.

MINDANAO, Cotabato Province, Nupol, March 29 to April 2, 1932 (*Rivera*); holotype, male; allotype, female; paratypes, several, both sexes; Barrio Lagdaan, April 4, 1932 (*Rivera*);

paratypes, males; Covell, Buayan, March 24 to 28, 1932 (*Rivera*); paratypes, males; Mount Matutum, April 9, 1932 (*Rivera*); paratypes, males.

Closely allied to *Gonomyia* (*Lipophleps*) *luteimarginata* Alexander (Luzon, Mindanao, Celebes, and New Guinea), differing evidently and conspicuously in the structure of the male hypopygium, such as the total lack of small spinules along mesal edge of outer dististyle, these being replaced by a single triangular blackened tooth near the basal spine, and in the quite different structure of the inner dististyles and gonapophyses.

GONOMYIA (LIPOPHLEPS) SUBPILIFERA sp. nov. Plate 1, fig. 21; Plate 3, fig. 40.

Belongs to the *pilifera* group; pleural stripe poorly defined; femora with inner dark annulus narrow and poorly indicated; wings whitish, with restricted brown areas and very pale gray washes on basal half; male hypopygium with the outer dististyle short, its apex a blackened point, with a small group of setæ close to tip.

Male.—Length, about 3.2 millimeters; wing, 2.8.

Rostrum and palpi blackish brown. Antennæ with scape and pedicel reddish brown; flagellum darker brown. Head brownish gray.

Mesonotal præscutum gray, the median portion weakly infuscated; pseudosutural foveæ black, conspicuous; posterior sclerites of mesonotum not visible in the unique type. Pleura brownish gray, with a clearer gray longitudinal stripe across the ventral sclerites. Halteres dusky, the base of stem narrowly orange, the knobs obscure. Legs with femora obscure yellow, with a broad brownish black subterminal ring and indications of a second, narrow, pale brown ring at near two-thirds the length of the segment; tibiæ obscure yellow, the tips narrowly dark brown; basitarsi obscure yellow, the tips and remainder of tarsi blackened. Wings (Plate 1, fig. 21) whitish, with a restricted brown pattern, as in the group; restricted brownish areas at arculus, tip of Sc and origin of Rs, tip of R_3, and along cord and outer end of cell 1st M_2; stigma oval, somewhat paler grayish brown; paler gray washes across basal half of wing; veins pale, darker in the clouded areas. Venation: Sc_1 ending opposite origin of Rs, Sc_2 at its tip; m-cu before fork of M.

Abdominal segments dark brown, ringed caudally with paler; hypopygium obscure yellow. Male hypopygium (Plate 3, fig. 40) with the characters as in group, inner dististyle, *id,* with a

densely setiferous pale cushion at base; basistyle, *b*, with pale digitiform lobe on mesal face; phallosome, *p*, produced into two slender needlelike spines. Differs from *pilifera* in the short outer dististyle, *od*, which is only slightly arcuated, immediately before tip with a small group of setæ, the apex beyond this point a short black spine. Ædeagus a slender dark spine, provided with small appressed setulæ.

MINDANAO, Davao district, Tagum, Madaum River, at trap lantern, March 26, 1931 (*Clagg*); holotype, male.

Differs from *Gonomyia* (*Lipophleps*) *pilifera* (de Meijere), of Java and Sumatra, in the structure of the male hypopygium.

GONOMYIA (LIPOPHLEPS) INÆQUISTYLA sp. nov. Plate 1, fig. 22; Plate 3, fig. 41.

General coloration of notum dark brown; pleura variegated with brown and whitish, not striped longitudinally; legs dark brown to brownish black; wings with a faint brown tinge, unmarked except for the pale brown stigma; Sc short; male hypopygium with the dististyle of either side very different in structure from its mate of the opposite side.

Male.—Length, 2.7 to 2.8 millimeters; wing, 3 to 3.2.

Female.—Length, about 3 to 3.2 millimeters; wing, 3.2 to 3.4.

Rostrum obscure yellow; palpi dark. Antennæ dark throughout; verticils unsually abundant and elongate. Head dark gray.

Anterior lateral pretergites very restrictedly whitish. Mesonotum brown, darker brown medially, the humeral and lateral regions of præscutum more brightened; median region of scutum and the scutellum obscure yellow, the latter darkened medially at base; mediotergite darkened, pleurotergite pale yellow. Pleura variegated dark brown and whitish but without longitudinal pale stripes, as usual in the subgenus, the pattern more transversely tessellated; the pale color includes the dorsopleural region, posterior sternopleurite, and lower posterior angle of anepisternum, together with the meral region; the dark color includes most of anepisternum and sternopleurite, and the pteropleurite. Halteres dusky, the stem brighter at base. Legs with the coxæ dark brown; trochanters obscure brownish yellow; femora brownish black, the tibiæ and tarsi slightly paler brown. Wings (Plate 1, fig. 22) with a faint brown tinge, the stigmal region a little darker; veins dark brown. Venation: Sc_1 ending some distance before origin of the short Rs, Sc_2

some distance from its tip; Rs and anterior branch of same subequal, or the latter a little longer; r-m unusually long and arcuated, the basal section of R_5 correspondingly reduced.

Abdominal tergites dark brown, the sternites similar, narrowly bordered laterally and caudally with pale; hypopygium obscure yellow. Male hypopygium (Plate 3, fig. 41) with the dististyles of the two sides very different in structure; one, *d*, a small oval flattened plate, shorter than the apical lobe of basistyle, produced laterad into a curved black spine; dististyle of opposite side, *d*, much longer than the lobe of basistyle, slender, gently curved, the tip a narrow blackened spine with numerous setæ surrounding base of spine; on basal half a series of seven or eight long erect setæ.

MINDANAO, Davao district, Tagum, Madaum River, at trap lantern, March 27, 1931 (*Clagg*); holotype, male; allotype, female; paratypes, several of both sexes. NORTH CELEBES, Minahassa, Roeroekan, altitude 3,500 feet, April 11, 1931 (*Clagg*); paratype, male.

The species most similar to this in the Oriental fauna is *Gonomyia* (*Lipophleps*) *incompleta* Brunetti, which is readily separated by the symmetrical dististyles of the male hypopygium. Asymmetrical dististyles are frequent in New Zealand and certain Neotropical members of *Lipophleps*, but the present case marks the greatest extreme known to me, with the single exception of *G.* (*L.*) *perreducta* sp. nov., described in this paper.

Genus ERIOPTERA Meigen

Erioptera MEIGEN, Illiger's Magaz. 2 (1803) 262.

Subgenus METERIOPTERA subg. nov.

Characters as in typical *Erioptera*, differing as follows: Basal three or four segments of antennal flagellum united into a short, truncate-conical fusion segment (Plate 3, fig. 42), the entire organ thus with twelve or thirteen segments. Wings with cord beyond midlength (Plate 1, figs. 23 and 24); vein 2d A only moderately sinuous, the distal fourth deflected slightly cephalad and not strongly constricting cell 1st A. Male hypopygium (Plate 3, figs. 43, 44, and 45) with the outer dististyle, *od*, terminating in a group of appressed spinous setæ or spines; inner dististyle, *id*, with apical portion usually bent at a strong angle to main axis of style.

Type of subgenus.—Erioptera javanensis de Meijere (Oriental: Austromalayan).

Other included species: *Erioptera angustifascia* Alexander (North Queensland), *E. fervida* sp. nov., *E. festiva* sp. nov., *E. geniculata* Edwards (Borneo and Mindanao), and *E. notata* de Meijere, with allied species or races (Oriental). All of the above forms, with the exception of *fervida* and *notata*, sens. lat., have the tips of the femora narrowly and abruptly white, preceded by a more or less distinct darkened annulus. *Erioptera rogersi* Alexander (Formosa), which has whitened femoral tips, does not belong to this new group but is a true *Erioptera*.

ERIOPTERA (METERIOPTERA) FESTIVA sp. nov. Plate 1, fig. 23; Plate 3, figs. 42 and 43.

Mesonotum chiefly cinnamon to light brown, the caudal borders broadly pale; femora yellow, with a brown subterminal ring, the tips white; wings yellow, with brown seams at origin of Rs, along cord and at tip of R_{1+2}; male hypopygium with the outer half of inner dististyle bent at an obtuse angle, the tip a blackened spine.

Male.—Length, about 2.5 millimeters; wing, 3.3.

Female.—Length, about 3 to 3.2 millimeters; wing, 3.5.

Rostrum yellow; palpi dark brown. Antennæ with the large scape and pedicel dark brown, the flagellum paler, especially the basal segments; ten flagellar segments beyond the conical fusion segment (Plate 3, fig. 42). Head pale brown.

Pronotum pale yellow. Mesonotum light cinnamon to pale brown, the humeral region and lateral borders of præscutum broadly whitish. Pleura chiefly brown, light in female, darker in male, variegated by silvery white on anepisternum, posterior portion of sternopleurite, meral region, and beneath the wing root. Halteres chiefly pale, the knobs weakly darkened, especially in the female. Legs with coxæ pale, the fore coxæ somewhat darker; trochanters yellow; femora yellow, with a conspicuous brown to dark brown subterminal ring a little more than its own length before the white tips; remainder of legs pale yellow, the outer tarsal segments a trifle paler. Wings (Plate 1, fig. 23) yellow, sparsely patterned with brown, including a conspicuous seam along cord, a common brown spot at origin of Rs and on Sc_2, and a spot at tip of R_{1+2}; a much fainter, barely evident, area at tip of vein R_3; veins yellow, darker in the clouded areas.

Abdominal tergite chiefly yellow, in male with a brown subterminal ring; in female, the segments more or less bicolored, dark basally, the caudal borders brighter; hypopygium yellow. Male hypopygium (Plate 3, fig. 43) with the inner dististyle, *id*,

stout, the distal half bent at an obtuse angle, the basal end of the bent portion with a flattened flange, the apex a blackened spine. Outer angles of phallosomic plate dusky, weakly corrugated.

MINDANAO, Davao district, Tagum, Madaum River, at trap lantern, March 26–27, 1931 (*Clagg*); holotype, male; allotype, female; paratypes, 3 females.

Erioptera (*Meterioptera*) *festiva* is amply distinct from the other species of the subgenus, especially in the heavier wing pattern and in the structure of the male hypopygium. . The distinctions between the three allied members of the subgenus in the Philippines having the femoral tips white are best shown by the following key:

1. Wings unmarked (Java, Borneo, and Mindanao).
javanensis de Meijere.
Wings with at least the cord and origin of Rs seamed with darker..... 2.
2. Small brown marginal spots at ends of veins R_{1+2} and R_3 (Mindanao).
festiva sp. nov.
No dark markings at ends of veins R_{1+2} and R_3 (Borneo and Mindanao).
geniculata Edwards.

ERIOPTERA (METERIOPTERA) JAVANENSIS de Meijere.

Erioptera javanensis DE MEIJERE, Tijd. voor Entom. 54 (1911) 45–46, pl. 3, fig. 28 (male hypopygium).

Described from Java. MINDANAO, Davao district, Tagum, Madaum River, at trap lantern, March 26–27, 1931 (*Clagg*); Cotabato Province, Buayan, May 8, 1932 (*Rivera*).

ERIOPTERA (METERIOPTERA) GENICULATA Edwards.

Erioptera geniculata EDWARDS, Journ. Fed. Malay States Mus. 16 (1931) 498–499.

Described from Bettotan, North Borneo. MINDANAO, Davao district, Tagum, Madaum River, at trap lantern, March 26–27, 1931 (*Clagg*), several specimens. The male hypopygium (Plate 3, fig. 44) is very similar to that of *javanensis*, but the spinous points at apex of outer dististyle, *od*, appear to be more delicate and more numerous. *Erioptera* (*Meterioptera*) *angustifascia* Alexander,[15] from North Queensland, is very similar to *geniculata* and may prove to be the same. The male sex is unknown and it is definitely unsafe to place virtually any described crane fly as a synonym without a knowledge of the male hypopygium.

[15] Proc. Roy. Soc. Queensland 32 (1920) 96–97.

ERIOPTERA (METERIOPTERA) FERVIDA sp. nov. Plate 1, fig. 24; Plate 3, fig. 45.

General coloration dull black, including halteres and legs; wings with a blackish suffusion; outer end of vein 2d A only shortly sinuous; male hypopygium with the inner dististyle stout, bent at a right angle into a powerful spine.

Male.—Length, about 2.5 millimeters; wing, 2.9 to 3.

Rostrum and palpi dull black. Antennæ with scape brown; pedicel brownish black; flagellum paler, more yellowish brown; flagellar segments beyond the fusion with long conspicuous verticils. Head brownish black.

Thorax uniformly blackened, opaque. Halteres and legs blackened. Wings (Plate 1, fig. 24) with a blackish suffusion; veins and macrotrichia still darker. Macrotrichia of veins long and coarse. Venation: Forks of radial and medial cells relatively shallow; R_{2+3+4} fully twice r-m; m-cu shortly before fork of M; outer end of vein 2d A only slightly sinuous.

Abdomen black. Male hypopygium (Plate 3, fig. 45) with the outer dististyle, *od,* weakly clavate, the apex set with coarse short spines. Inner dististyle, *id,* bent at a right angle at near midlength, the apex a powerful spine, the inner margin roughened by microscopic papillæ. Gonapophyses, *g,* appearing as slender, curved blackened hooks.

MINDANAO, Cotabato Province, Pauayan, May 8, 1932 (*Rivera*); holotype, male; allotype, female; paratypes, both sexes.

The present fly is undoubtedly allied to *javanensis,* despite the coloration of the body and appendages. Its general appearance is much like that of *Erioptera* (*Teleneura*) *fusca* de Meijere, but the two flies are distantly related.

The complex of races or closely allied species that center about *Erioptera* (*Meterioptera*) *notata* de Meijere belong to a different group from all the above, differing in the shape of the outer dististyle of the male hypopygium.

ERIOPTERA (ERIOPTERA) BIARMATA sp. nov. Plate 3, fig. 46.

General coloration pale reddish yellow; antennæ with segments of basal half pale, the outer segments darkened; halteres with blackened knobs; legs yellow; male hypopygium with the outer dististyle bifid beyond midlength into two acute black spines that diverge at an acute angle; inner dististyle simple; phallosome entirely pale.

Male.—Length, about 3.5 to 4 millimeters; wing, 4 to 4.8.

Rostrum yellow; palpi brownish black. Antennæ with scape, pedicel, and basal four or five flagellar segments yellow, the succeeding segments infuscated; flagellar segments subcylindrical to truncate-fusiform, the longest verticils subequal to the segments; antennæ 16-segmented, as normal. Head reddish yellow, the anterior vertex paler.

Pronotum yellowish. Mesonotum almost uniformly pale reddish, the posterior sclerites somewhat more reddish yellow. Pleura yellow. Halteres yellow, the knobs black. Legs yellow, the terminal tarsal segments weakly darkened. Wings yellow, the veins darker yellow; macrotrichia brown. Venation: Vein 2d A unusually long-sinuous, cell 1st A at midlength being more than twice as wide as just before outer end.

Abdomen brownish yellow, somewhat darker subterminally; hypopygium yellow. Male hypopygium (Plate 3, fig. 46) with the apex of basistyle, *b*, a little produced caudad beyond point of insertion of the dististyles; mesal face of style with dense erect setæ. Outer dististyle, *od*, bifid beyond midlength into two acute black spines that diverge at an acute angle, the outer or axial spine longer. Inner dististyle, *id*, simple, at apex slightly dilated into a spatula that is armed with several setigerous punctures. Phallosome appearing as two slender rods that are united at base to appear more or less like a tuning fork, each rod expanded laterad into a broad pale blade, the entire phallosomic region pale.

LUZON, Mountain Province, Benguet, Haight's Place, Pauai, altitude 8,000 feet, October 6, 1931 (*Clagg and Rivera*); holotype, male; paratypes, males, October 5–6, 1931.

Very similar in general appearance to *Erioptera* (*Erioptera*) *lunicola* Alexander (Luzon and Mindanao), differing in the immaculate wings and, especially, the very different structure of the male hypopygium, which is distinct from that of any other species known to me, suggesting in some respects a species of the subgenus *Empeda; E.* (*E.*) *cacuminis* Edwards, of the mountains of Borneo, has a hypopygium that somewhat resembles that of the present fly, but the outer dististyle and phallosome, especially the latter, are entirely different.

ILLUSTRATIONS

[Legend: *a*, Ædeagus; *b*, basistyle; *d*, dististyle; *g*, gonapophysis; *id*, inner dististyle; *md*, middle dististyle; *od*, outer dististyle; *p*, phallosome; *t*, tergite.]

Plate 1

Fig. 1. *Limonia* (*Limonia*) *languida* sp. nov., wing.
2. *Limonia* (*Limonia*) *erratica* sp. nov., wing.
3. *Limonia* (*Limonia*) *melanoptera* sp. nov., wing.
4. *Limonia* (*Limonia*) *parvispiculata* sp. nov., wing.
5. *Limonia* (*Libnotes*) *circumscripta* sp. nov., wing.
6. *Limonia* (*Libnotes*) *rarissima* sp. nov., wing.
7. *Helius* (*Rhampholimnobia*) *brevinasus* sp. nov., wing.
8. *Trichoneura* (*Xipholimnobia*) *bontocensis* sp. nov., wing.
9. *Troglophila cotabatoensis* sp. nov., wing.
10. *Trentepohlia* (*Mongoma*) *carbonipes* sp. nov., wing.
11. *Trentepohlia* (*Mongoma*) *lætithorax* sp. nov., wing.
12. *Gonomyia* (*Ptilostena*) *cotabatoensis* sp. nov., wing.
13. *Gonomyia* (*Ptilostena*) *metatarsata atrophia* subsp. nov., wing.
14. *Gonomyia* (*Gonomyia*) *pauaiensis* sp. nov., wing.
15. *Gonomyia* (*Gonomyia*) *gratilla* sp. nov., wing.
16. *Gonomyia* (*Gonomyia*) *longifimbriata* sp. nov., wing.
17. *Gonomyia* (*Gonomyia*) *versicolor* sp. nov., wing.
18. *Gonomyia* (*Lipophleps*) *perreducta* sp. nov., wing.
19. *Gonomyia* (*Lipophleps*) *pinivagata* sp. nov., wing.
20. *Gonomyia* (*Lipophleps*) *ramifera* sp. nov., wing.
21. *Gonomyia* (*Lipophleps*) *subpilifera* sp. nov., wing.
22. *Gonomyia* (*Lipophleps*) *inæquistyla* sp. nov., wing.
23. *Erioptera* (*Meterioptera*) *festiva* sp. nov., wing.
24. *Erioptera* (*Meterioptera*) *fervida* sp. nov., wing.

Plate 2

Fig. 25. *Limonia* (*Limonia*) *languida* sp. nov., male hypopygium.
26. *Limonia* (*Limonia*) *erratica* sp. nov., male hypopygium.
27. *Limonia* (*Limonia*) *melanoptera* sp. nov., male hypopygium.
28. *Limonia* (*Limonia*) *parvispiculata* sp. nov., male hypopygium.
29. *Limonia* (*Libnotes*) *circumscripta* sp. nov., male hypopygium.
30. *Limonia* (*Libnotes*) *rarissima* sp. nov., male hypopygium.
31. *Trichoneura* (*Xipholimnobia*) *bontocensis* sp. nov., male hypopygium.
32. *Gonomyia* (*Ptilostena*) *cotabatoensis* sp. nov., male hypopygium.
33. *Gonomyia* (*Gonomyia*) *pauaiensis* sp. nov., male hypopygium.
34. *Gonomyia* (*Gonomyia*) *gratilla* sp. nov., male hypopygium.
35. *Gonomyia* (*Gonomyia*) *longifimbriata* sp. nov., male hypopygium.

PLATE 3

FIG. 36. *Gonomyia* (*Lipophleps*) *perreducta* sp. nov., male hypopygium.
37. *Gonomyia* (*Lipophleps*) *pinivagata* sp. nov., male hypopygium.
38. *Gonomyia* (*Lipophleps*) *ramifera* sp. nov., male hypopygium.
39. *Gonomyia* (*Lipophleps*) *diacantha* sp. nov., male hypopygium.
40. *Gonomyia* (*Lipophleps*) *subpilifera* sp. nov., male hypopygium.
41. *Gonomyia* (*Lipophleps*) *inæquistyla* sp. nov., male hypopygium.
42. *Erioptera* (*Meterioptera*) *festiva* sp. nov., antenna, male.
43. *Erioptera* (*Meterioptera*) *festiva* sp. nov., male hypopygium.
44. *Erioptera* (*Meterioptera*) *geniculata* Edwards, male hypopygium.
45. *Erioptera* (*Meterioptera*) *fervida* sp. nov., male hypopygium.
46. *Erioptera* (*Erioptera*) *biarmata* sp. nov., male hypopygium.

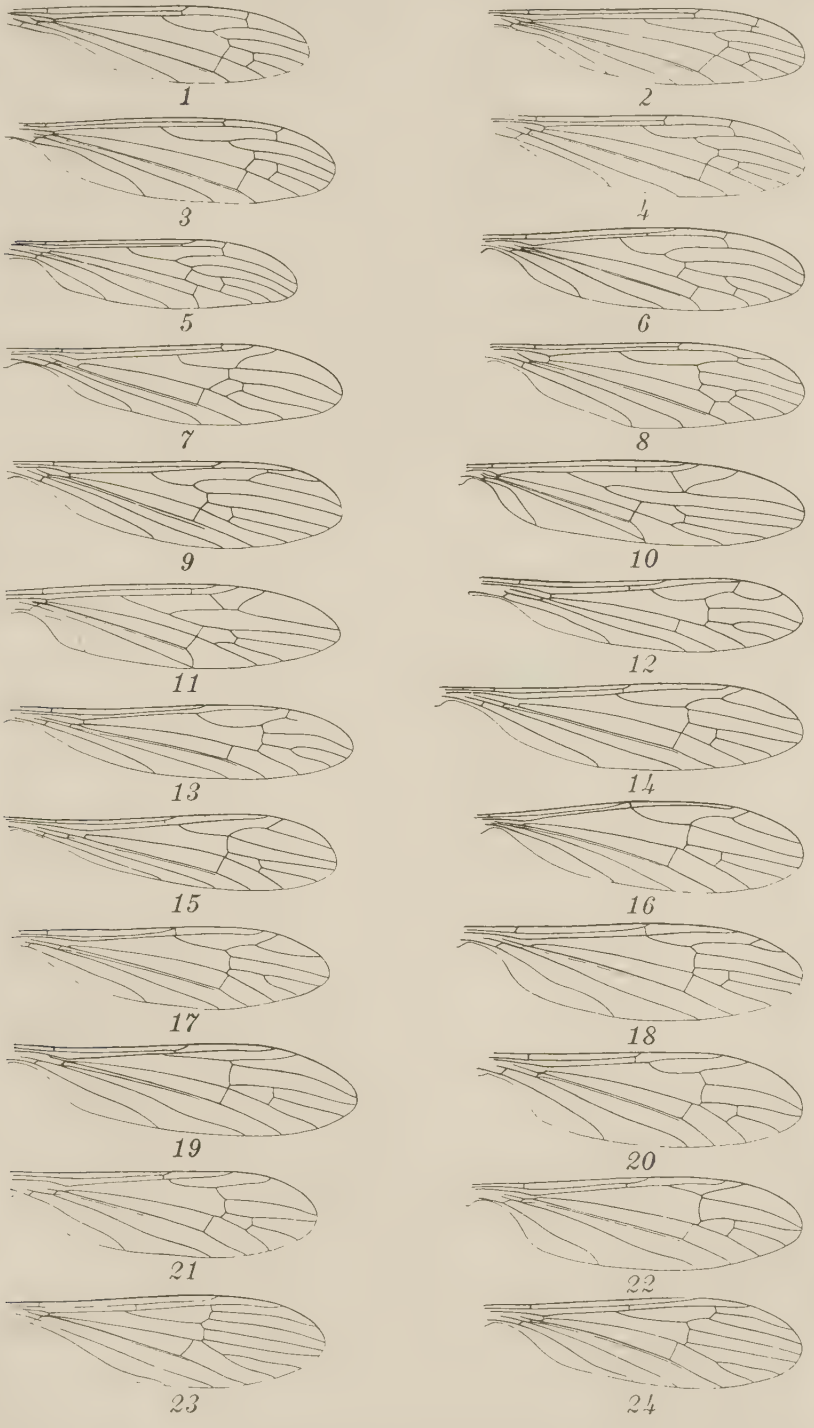

PLATE 1.

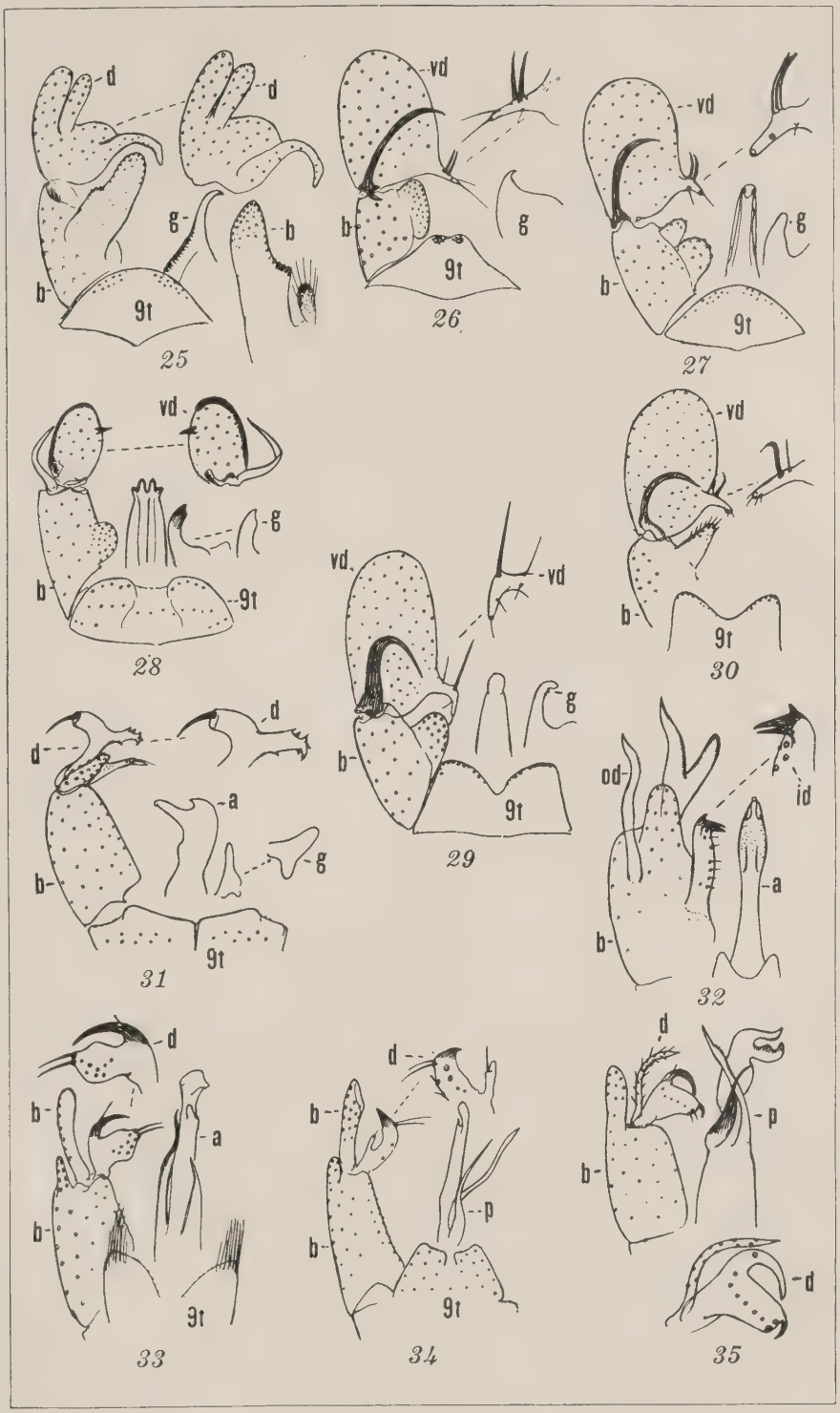
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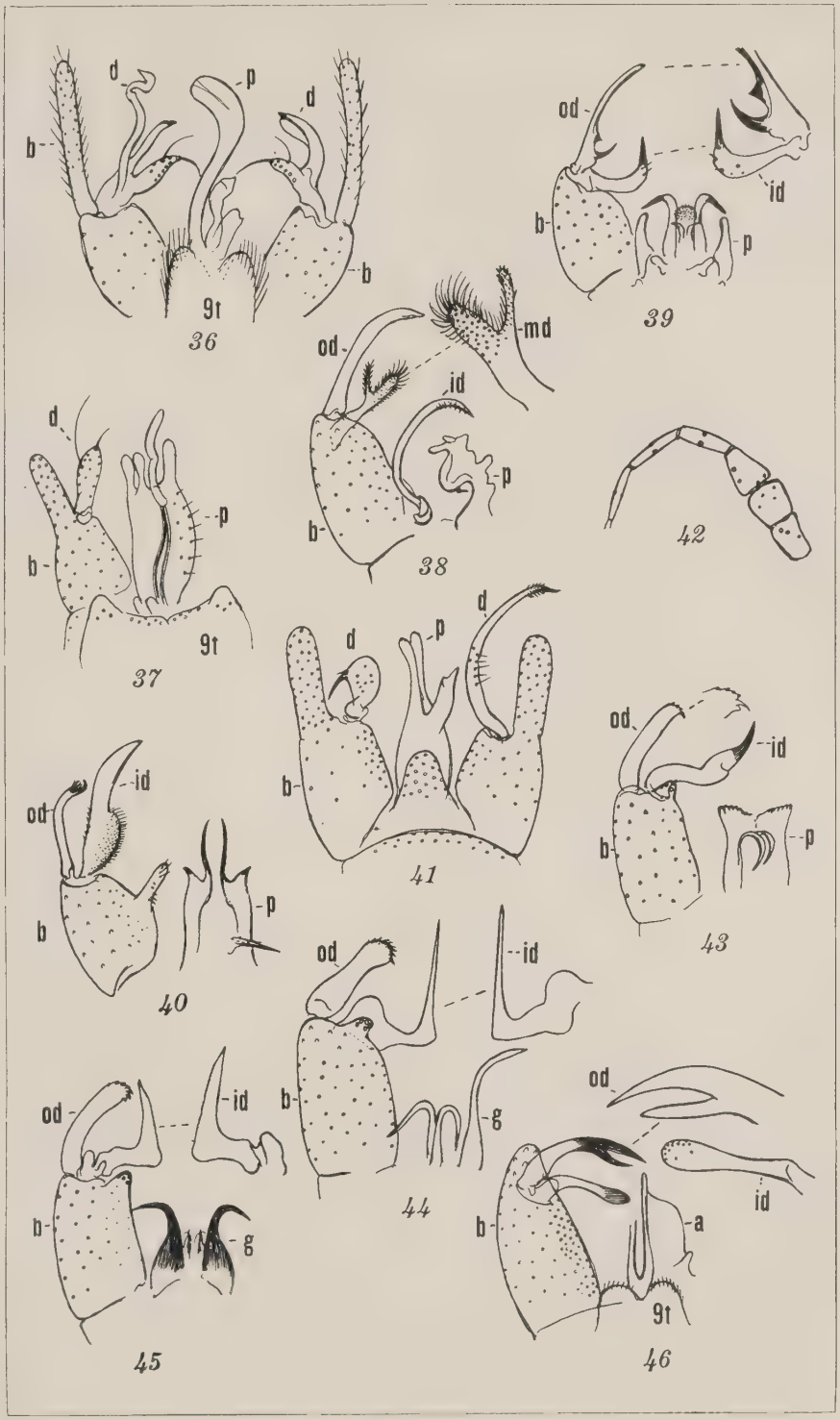
PLATE 2.


d
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9t
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id
b
p
40
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46

PLATE 3.

CHIRONOMIDÆ FROM JAPAN (DIPTERA), III

THE EARLY STAGES OF A SEASHORE BITING MIDGE FORCIPOMYIA CRINUME (TOKUNAGA) [1]

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THREE PLATES

In 1932 I reported on a new biting midge collected from a shore plant, *Crinum asiaticum* var. *japonicum* (Amaryllidaceæ) and named it *Dasyhelea crinume*. On examining more extensive material I came to regard this species as properly belonging to the genus *Forcipomyia* sensu lato. The characteristic structures of the early stages of the present fly coincide almost perfectly with those of *Apelma* Kieffer, a special group of *Forcipomyia*, which was recently studied by Saunders (1925) in detail. Habits and habitat of the early stages of the present fly are also closely similar to those of the *Apelma* group, the young flies being found among the bases of succulent leaves of shore plants. As pointed out by Saunders, who placed this group in a separate genus, the dependable distinctive adult characters are, first, the characteristic H-shaped internal chitinization of the male hypopygium and, second, the absence of empodia in the male and their presence in the female; while in the present fly, although the first character is distinctly shown, the empodia of both sexes are all well developed as in the other *Forcipomyia* species. Edwards (1926) condensed separate genera, *Apelma*, *Euforcipomyia*, *Thyridomyia*, and *Ceratopogon*, into a single genus *Forcipomyia* on the basis of the close similarity in the adult structures, especially in the wing, although this genus was subdivided into four groups by the relative lengths of the first hind tarsal segment to the second. According to his system, the present fly, which shows the following proportional lengths in the hind tarsal segments, 16 : 5 : 5 : 4 : 4 is duly included together with the other known *Apelma* species in the group

[1] Contribution from the entomological laboratory of the Kyoto Imperial University, No. 40.

where the long basitarsal segment is two or more times as long as the second segment.

As stated above, although *Forcipomyia crinume* is distinctly different from the original generic diagnosis of *Apelma* as given by Kieffer in the presence of the empodia in the male fly,[2] this species is thought to belong properly to the *Apelma* group of *Forcipomyia* sensu lato, taken in connection with the presence of the H-shaped chitinization of the male hypopygium and the close similarity of the immature forms, as will be shown in detail below.

The imago of the present species is somewhat similar in coloration to *F. bromelicola* Lutz or *F. edwardsi* Saunders, but it is easily distinguished by the dark brown or dark scutellum, mesopleura, and metapleura. The hypopygium of the male closely resembles that of *F. keilini* Saunders, *F. brevis* Johannsen, and *F. edwardsi* Saunders, but differs in the distinctly setigerous and nonspoonlike styli and less-setigerous ninth sternum.

I am greatly indebted to Prof. Hachiro Yuasa for his kind direction of this work, and I also thank Prof. A. Thienemann for his kind suggestion with regard to the taxonomy of this fly.

MORPHOLOGY OF THE PUPA

The pupæ are free mummy in type, the larval skin being not retained, depressed dorsoventrally, flattened in general appearance, about 1.7 to 2.5 mm in length in the male and 1.9 to 2.9 mm in the female. The coloration varies from pale yellow to dark brown, according to the stage of development. The pupal exuvia is hyaline and pale yellow, slightly fuscous in the head, thorax, and last abdominal segment.

HEAD

The head is flattened and somewhat hexagonal in the ventral aspect. The exuvia is slightly brownish on the dorsal side and hyaline on the ventral aspect. The dorsal surface is distinctly sculptured with minute dots or tubercles and provided with the V-shaped epicranial suture which splits open in the process of emergence. On the median triangular area between the arms of the epicranial suture there are two small tubercles each of which bears a small seta. The similar paired tubercles of the median piece are also known in *F. brevis, F. bromelicola,*

[2] In *F.* (*Apelma*) *brevis* Johannsen, according to Johannsen the empodium of the male fly is not completely wanting but vestigial.

and *F. magna*, but the setæ on the tubercles are not mentioned. In the present pupa the lateral pieces are provided with small setæ and sensory pits where the tubercles would be expected in the other species, such as *F. keilini* and *F. palustris*. The ventral surface is almost smooth, slightly rugulose on the shallow median furrow, and distinctly sculptured with minute dots on the areas of the compound eyes. The region of the frontoclypeus is large, and provided with a pair of minute setæ on its marginal region near the base of the labral sheath. The region of the gena forms a distinct flattened ridgelike projection along the caudal margin.

The labral sheath is a small projection. The sheath of the maxillary palpus is comparatively large, arises from the caudal margin between the labral and the genal projections, and protrudes caudad forming a distinct lobe. The labial sheath is very small, externally visible, located along the concave mesal margin of the sheath of the maxillary palpus, and the paired labial sheaths are distinctly separated from each other at the apex of the labral sheath.

The sheaths of the antennæ are very large, pale brown, arise from the laterocephalic corners of the head, extend caudad around the lateral margins of the head, and end between the bases of the wing sheaths and the middle leg sheaths as in *Forcipomyia* (sensu lato) in general. The surface of the antennal sheath is sculptured with minute brown tubercules and obscurely constricted by shallow hyaline furrows corresponding to the segmentation of the imaginal antennæ.

It may be noteworthy that in the present pupa there are a few small setæ on the dorsal region of the head, and a pair of minute simple setæ on the frontoclypeus, while on the pupal head of the *Apelma* group Saunders states that two or three papillæ, but never setæ, occur on the head.

THORAX

The thorax is flattened. The dorsum of the thorax is almost smooth, slightly sculptured with minute dotlike tubercules on the lateral region, and is not provided with distinct cuticular spinelike projections differing from those of the *Forcipomyia* (sensu stricto), *Atrichopogon*, *Kempia*, and *Gymnohelea* groups. The cephalic margin of the thorax is deeply invaginated along the cervical membrane. The mesothorax and metathorax are distinctly divided by a V-shaped suture. The lateral area of the thorax is irregularly rugous, being bluntly projected along

the longitudinal line forming a low ridge. The distinction of the areas corresponding to the adult thoracic sclerotization is very obscure. The middorsal suture is extended throughout the entire length of the thorax from the caudal angle of the V-shaped epicranial suture to the tip of the posterior median projection of the thorax. There is one pair of minute sensory pits on the cephalic region near the bases of the prothoracic respiratory horns, one pair of small blunt setigerous papillæ on the middle of the dorsum, and one pair of minute sensory pits on the caudal region of the mesothorax near the laterocaudal concavities of the mesonotum. The caudal end of the mesonotum triangularly projects caudad across the metanotum and is extended to the anterior border of the first abdominal segment forming the posterior median point. Both setæ and papillæ are wanting on this region, differing in this from the *Forcipomyia* group. The caudolateral margins of the mesonotum, between the caudal projection and the bases of the wing sheaths, are almost entirely round as in *F. bromelicola* and *F. keilini*, but each margin bears a minute shallow incision which is not so distinct as in *F. edwardsi*, *F. magna*, and *F. comis*. The metanotum is completely separated into the lateral halves by the caudal projection of the mesonotum and each half is provided with a minute seta and one or two sensory pits.

The prothoracic respiratory horns (Plate 1, figs. 3 and 4) are long, slender, subcylindrical, drumsticklike, resembling those of *F. comis*, greatly differing from those of *Forcipomyia* (sensu stricto), but rather similar to those of certain Culicoidinæ vermiformes; namely, *Bezzia* and *Palpomyia*. The entire surface is finely rugulous and without distinct imbrication. The distal region is distinctly flattened in circle in the lateral aspect and the mesal surface is somewhat concave. Along the margin of this distal circular area respiratory pores are arranged in a horseshoeshape. These respiratory pores are all round, comparatively large, independently opened, being not confluent, subequal in size to each other, and about eleven in number on each horn. The respiratory horns are movably articulated on special blunt projections. Usually these horns are directed dorsolaterocaudad.

The sheaths of the wings and legs are extended caudad, but not beyond the anterior border of the first abdominal sternum. The sheaths of the wings are comparatively short but broad and sculptured with minute dots on the basal surface. The mesal margins of the paired wing sheaths are parallel in position

and widely separated from each other. The caudal margins of the paired sheaths do not form a straight line, but each is slightly oblique, forming a shallow inverted V in the ventral aspect. On the lateral part of this caudal margin there is a small hump as in the Ceratopogoninæ in general.

The sheaths of the legs are comparatively short but stout and almost smooth. The foreleg sheaths are entirely visible in the ventral aspect. The region corresponding to the femur and tibia is very large, while that of the basitarsus is suddenly narrowed, then the mesal margin of the flattened foreleg sheaths seems to be incised deeply at the joint of the tibia and tarsus. The region corresponding to the tarsus is dilated and flattened distinctly and not provided with distinct constrictions corresponding to the segmentation of the tarsus. The basitarsal region is elongated and somewhat triangular and forms a V-shaped triangular space between the paired basitarsal sheaths. The distal regions of the paired foreleg sheaths which contain the distal four tarsal segments of the adult legs are parallel, extending between the mesal margins of the wing sheaths, closely contiguous to each other on the midventral line and ended far before the distal tip of the wing sheath.

Each middle leg sheath is extended along the lateral side of the forelegs and ended beyond both tips of the forelegs and wing sheaths reaching the same level as the wing humps. The major region of the sheath is hidden under the wing and foreleg sheaths and only the region of the tibia and the distal tip are externally visible. The femoral region is found under the fore tibial region, the tibial region between the fore tibial region and the wing sheath, and the tarsal region excepting its tip under the wing sheath. The tarsal region is distinctly divided into four parts by three brown constrictions. The distal part is suddenly dilated mesad, being closely contiguous with the opposite part and fill up the space between the wing sheaths. The distal two tarsal segments of the imago are found within this part.

The hind leg sheaths are hidden under the wing sheaths and only the distal tips are externally visible. The region of the tibia and femur is extended along the lateral side of the middle leg sheath but the tarsal region is extended laterad and then caudomesad and ended beyond the tips of the wing sheaths on the same level as the middle leg tips, being closely applied with the middle leg sheaths at a right angle. The tarsal region of the hind leg is flattened and large, shallowly and imperfectly

constricted into four parts. The proximal part is large, extended caudolaterad and contains the adult basitarsus. The remaining part is extended caudomesad and dilated distad. The dilated distal part contains the distal two segments of the adult hind leg. The exposed tip of the hind leg sheath is tinged brown and sculptured with minute dots.

The halteres seem to be not provided with their special sheaths, formed within the common space of the metathorax and externally visible through the pupal skin in the dorsal aspect along the anal margins of the wing sheaths.

These principal arrangements of the thoracic appendages seem to be prevalent among the related groups of *Forcipomyia*, judging from the figures given by various writers (Johannsen, Mayer, Saunders, and others).

ABDOMEN

The larval exuvia is not retained by the pupa, and the pupal abdomen bears distinct setigerous tubercles or papillæ on all sides of each segment and its general appearance somewhat resembles that of *F. comis* and *F. keilini*. On the cephalic two and the penultimate eighth abdominal segments the cuticular projections are somewhat reduced and modified. The surface of each segment is sculptured with minute dotlike brown tubercules and more or less rugulous with longitudinal waved lines on the dorsomesal and ventromesal areas. The sternal side of the first and second segments is covered by the wing and leg sheaths and is quite smooth, without tubercles and papillæ.

Typically six pairs of setigerous tubercles are transversally arranged on each segment as shown in Plate 1, fig. 5. These tubercles are more or less imbricated, at least on the basal region. Of these tubercles the lateral two, *c* and *d*, are provided with a simple seta on each tip; the seta of *c* is very long while that of *d* is minute. The tubercles *b* and *f* are provided with two or more simple setæ on each base. The remaining two, *a* and *e*, are devoid of setæ. Besides these tubercles there are two pairs of sensory pits: one pair on the caudal region of the dorsomeson and the other on the dorsolateris near the tubercles *b*. On the lateral side between the tubercles *b* and *c* the rudiments of the abdominal spiracles are found, being tinged pale brown in the exuvia.

On the first abdominal segment a vestigial setigerous papilla, which takes the place of the tubercle *c*, is found on the dorso-

latus; the tubercle *a* is replaced by a single seta found on the cephalic margin and other tubercles are all completely atrophied. On the second abdominal segment the tubercle *a* is also replaced by a single seta and *c, d, e,* and *f* are all greatly reduced, being represented only by minute papillæ, each of which is crowned with a minute seta. The dorsomedian sensory pits are distinctly present on both the first and second segments. On the eighth abdominal segment the tubercles *d* and *b* are reduced, being replaced by simple setæ. Other tubercles are as well developed as in the other segments. These well-developed tubercles on the caudal abdominal segments are not found in the *Forcipomyia* group, which retains the last larval skin on the caudal four or five pupal segments.

The genital sheaths of both sexes are situated on the ventral side of the ultimate segment. This ventral position of the genital sheaths, according to Saunders, is the most important character that separates the *Apelma* group from the other groups of *Forcipomyia* sensu lato. The ultimate segment is distinctly sculptured with minute brown tubercules but without setigerous tubercles or papillæ. The paired caudal processes (Plate 1, figs. 1 and 2) are subequal in structure in each sex, comparatively slender but not so slender as in *F. comis,* extended caudad almost parallel, distinctly imbricated on the entire length and curved slightly dorsolaterad on the distal half. The genital sheaths are hyaline, without minute tubercles but rugulous with transversal waved lines and partially bilobated by the ventromedian constriction. In the male the genital sheaths are larger than in the female. The *Apelma* group as a whole is provided with a pair of lateral setæ on the bases of the caudal processes, while in the present species the setæ were not observed even in the pupæ just after pupation. Instead of the setæ two pairs of minute pitlike structures are definitely found both in the pupæ (31) and exuviæ (17) of both sexes. Of these pairs one pair is found on the lateral sides near the bases of the genital sheaths and the other on the ventral side of the bases of the caudal processes. Whether these pits are due to the falling out of setæ or not remains unknown.

MORPHOLOGY OF THE LARVA

The larva is slender, yellowish semihyaline in life, and white in alcoholic specimens, measuring about 5 millimeters in length in the full-grown stage. The setæ are all slender, inconspicuous,

and there are no modified hairs such as the "finned" and blade-like hairs found in *F. edwardsi, F. comis,* and *F. magna.*

The larva of the present species is somewhat different from that of the *Apelma* group mentioned by Saunders in the structure of the median posterior prolongation of the body (cauda) and in the chætotaxy of the body. However, judging from the structures of the head, mouth parts, antennæ, prothoracic pseudopod, etc., the present larva possesses many important characters of the *Apelma* group.

HEAD

The head is pale yellow and heavily thickened and deeply pigmented only on its cephalic and caudal margins, distinctly depressed dorsoventrad, somewhat elongated and oval in shape, the width and the length of the head showing the proportion, 12: 19 (Plate 2, fig. 9). The head is extended in the same axis as the body as in the *Apelma* group, and never directed downwards as in the other groups of *Forcipomyia* (sensu lato); namely, *Thyridomyia, Forcipomyia, Atrichopogon, Kempia,* and *Gymnohelea.*

On the dorsocaudal area of the head there is a delicate epicranial suture. This suture is somewhat U-shaped, distinctly angulated and not extended beyond the eyes, differing from the other known larvæ of the *Apelma* group.

The eyes are found on the laterodorsum on the middle of the head capsule at the ends of the epicranial arms. The mass of the black pigment is comparatively small but distinct, oval in shape in the laterodorsal aspect, and not distinctly bilobated. Upon this pigmental mass a clear small round spot is found.

The antennæ of the present larva (Plate 2, figs. 9 and 11) show a characteristic structure for the *Apelma* group radically differing from the other groups of *Forcipomyia.* They are located on the laterocephalic angles near the base of the labrum, somewhat pyriform, being slightly constricted only on the mesal margins, hyaline, delicately membranous in structure, and set in openings in the chitin of the head. This membranous disk of the antenna consists of two regions. The small cephalic region is the antenna proper, slightly raised and provided with a lunate thickening which suggests the basal portion of the normal larval antenna, and on the central round membrane there are five minute sensillæ. The large posterior region is very slightly tinged yellow contrasting with the peripheral hyaline membrane, on the center there is a deep pore from which many

very minute papillæ are radially arranged in twelve lines. On the constricted mesal margin there is an isolated sensory papilla on the basal brown ring.

The raised feature and annular structure of the present antenna somewhat resemble those of *F.* (*Thyridomyia*) species, although not so conspicuous as in the *Thyridomyia* larvæ. The posterior region of the antenna seems to be more or less developed in the *Apelma* group as a whole, judging from the figures given by Saunders and Mayer, but in the other species this region is far more inconspicuous than in the present larva. This caudal organ appears to resemble somewhat the postantennal organs of the Collembola, but their exact relation is doubtful.

The chætotaxy of the head closely corresponds to that shown by Saunders. The setæ are all simple, slender, dark brown, and grow on the minute membranous tubercles, as shown in Plate 3, fig. 19. There are ten pairs of setæ, four pairs of minute sensory setæ, and three pairs of sensory pits on the surface of the head capsule. Three pairs of long setæ, *a*, *b*, and *f*, are on the dorsum; one pair of small setæ, *c*, near *b;* one pair of closely associated long and short setæ, *j*, at the base of the labrum; three pairs, *d*, *e*, and *h*, on the lateral side; one pair of long setæ, *g*, on the ventromeson and the closely situated long and short setæ *i* at the base of the maxillæ. The arrangement of the minute sensory setæ is as follows: Two pairs, *k*, on the dorsocaudal margin, one pair, *l*, just behind the eyes, and one pair, *m*, on the ventrocaudal margin. The position of the three sensory pits is as follows: One dorsal pair, *n*, is found before the setæ *f* or behind the labrum; one laterocephalic pair, *p*, near the setæ *e*, and one laterocaudal pair, *o*, just behind the setæ *d*. In the present case the ventral pair of setæ, *g*, is found far more caudad than in the other *Apelma* larvæ in which this pair (designated as *y* in the figure of Saunders) is found on the transverse line passing through the setæ *b* and *c*.

MOUTH PARTS

The mouth opening is entirely on the ventral side, somewhat elliptical in shape and strongly reënforced with chitin on its margin. The various appendages are highly modified and reduced from those of the typical nematocerous larvæ.

The clypeolabrum (Plate 2, fig. 9) is the median cephalic prolongation of the head and there is no distinction of the clypeus and the labrum as they are uniformly thickened on the dorsal aspect. The distal margin of the labrum is membranous

and somewhat extended ventrad and then backwards forming a membranous ridge. The lateral side of the labrum (Plate 3, fig. 16) is provided with a secondary thickened sclerite which is formed by the fusion of the clypealiæ and labraliæ (*ll*). The ectal part of this thickening is mainly represented by the labraliæ which are very thick on the proximal part and become thin on the distal part. The clypeolabrum is quite smooth and provided with only the closely associated short anterior and long posterior setæ (fig. 9, *j*) on its proximolateral margin of the thickened base of each labralia.

On the distoventral membranous area (Plate 3, fig. 16, *lr*) of the labrum, distad of the labralia, there is a pair of sensory organs each of which consists of three minute fleshy papillæ and a brown setigerous tubercule. On the ventromeson of the labral projection there are two similar sensory organs which are closely situated on the thin distal area of the labraliæ. This organ is composed of three trichoid sensillæ, two fleshy papillæ, and one setigerous papilla.

The ental thickening of the labralia forms a projection, which is known as "pieces triangulaires" (Goetghebeur), for the articulation of the premandible, and closely associated with the ental thickening of the clypealia, forming a large rhombic skeleton at the base of the labrum or dorsad of the mandibular chamber.

The ventral surface of the clypeolabrum (Plate 3, fig. 16), caudad of the labralia, is thinly membranous and extends caudad, eventually forming the roof of the mouth cavity. This membranous area consists of the fusion of the epipharynx and epigusta, losing the external marks of the tormæ which divide these two regions and clothed with fine hairs and spines on the median ridge. The cephalic group of the hairs is composed of many minute spines, one pair of short setæ, three hyaline spines, and one pair of long strong setæ. The caudal group is composed of the uniform minute pubescence.

On the ventral membrane of the labrum there is a pair of small solid thickenings, which are known as the premandibles. The term "premandibles" applied to the nematocerous larvæ was proposed by Goetghebeur (1912) for chironomids, but is not homologous with the premandibles of Campodiidæ (Apterygota), and according to Saunders (1924) and Puri (1925) in the Chironomidæ the premandibles are derived from the local secondary thickenings of the labrum.

In the present larvæ the premandibles (Plate 3, fig. 16, *pm*) are innervated from the frontal ganglion, similarly as in the

sensory organs of the labrum, and provided with the large and small paired muscles on each side. The larger of these two muscles extends caudad and ends on the dorsal wall of the head, while the small one ends on the lateral endoskeleton of the labrum. The premandibles of the present larva are moved in the longitudinal plane, as observed by Saunders in the *Forcipomyia* group, differing from the *Chironomus* larvæ in which they are so moved as to hold food between them. In the lateral aspect the premandible is somewhat L-shaped and supported by the ental thickening of the labralia at the angulated part of the former. The cephalic half of the L-shaped premandible is sunk under the epipharyngeal membrane forming the ental part of the premandible. The other half, the ectal part, is smaller than the former part and its apex is bilobated into blunt teeth. In the *Apelma* group Saunders stated that the premandible is divided into two separated pieces, as in *Dasyhelea,* but such a peculiar structure was not observed in this case.

The mandibles (Plate 3, fig. 16, *md*) are accommodated in a special mandibular chamber between the labrum and the maxillæ, very characteristic in form, consisting of a large hollowed proximal portion and a long slender distal portion and abruptly bent near the middle to an angle of nearly 90°, as stated by Saunders in the *Apelma* group. The mandibular chamber is large; its thin dorsal wall is directly continuous with the epipharynx; its ventral wall is the dorsal wall of the maxilla itself and into this chamber the basal portion of the mandible is received. The mandibles are moved in the horizontal plane, but at the same time each mandible is rotated about 90° by the large retractor and extensor tendons so as to have the curved end directed ventrad. Therefore, in this motion the slender distal portion is moved in the vertical plane along the margin of the maxilla. For the articulation of the mandible large strong endoskeletons (pièces triangulaires) arise from the cephalolateral corners of the mandibular chamber.

The tapering distal portion is provided with two spatulate distadentes on its tip. The proxadentes are completely wanting. A strong hyaline isolated spinelike projection is located on the dorsodistal part as in the other chironomid larvæ. The brustia consists of a single row of minute hairs on the mesal side of the slender distal portion. Other hairs are completely obsolete.

The maxillæ (Plate 3, fig. 16, *mx*) are large membranous lobes, occupying the major part of the ventral side of the mouth cavity, arising from the chitin surrounding the mouth

aperture and supported by irregularly-shaped endoskeletons on the dorsal side which arise from the anterior converging wall of the head and by slightly thickened slender stripes (cardo?) found on the dorsal wall of the maxillæ. Posteriorly the paired maxillæ meet above the mentum (known as the labial plate) and form a V-shaped mouth space between them. Near the mesal margin the ventral surface is provided with a single row of very short delicate hairs, on the cephalic corner with a vestigial maxillary palpus and a group of minute sensory papillæ. The maxillary palpus is membranous, sunk within a membranous socket, and crowned with three very minute fleshy papillæ. Near the conjunction of the paired maxillæ there is a chitinized and fleshy sensory papilla on the dorsal surface of each maxilla.

The labium is represented by the mentum (Plate 2, fig. 10, *mt*) only, the other structures being completely atrophied. The mentum consists of hyaline chitin and is connected by a membrane with the posterior thickened margin of the mouth aperture. Although this structure is well developed in the other chironomid larvæ, in this species as well as in the other members of the *Apelma* group it is very small, somewhat trapezoid, bilobate, provided with two teeth on each lobe, and different from the strong, nonserrated, fanlike projection of the *Forcipomyia* sensu stricto group.

The hypopharyngeal region is highly modified and complex in structure, accompanying various modified adjacent sclerites. The essential structure is similar to that in other Ceratopogoninæ shown by Saunders. The hypopharyngeal structures of the present larva does not form a tonguelike projection differing from the chironomid insects and these structures are displaced deeply caudad becoming located on the entrance of the œsophageal canal, as shown in Plate 2, fig. 9. This organ is not a single mass of sclerotization but composed of two main skeletons at least—namely, the dorsal (Plate 2, figs. 12 and 13) and the ventral (fig. 10) parts, and food is passed caudad between these two parts. Thus the ventral part may be homologous with the hypopharynx proper, but there is nothing to correspond to the dorsal part among the other nematocerous larvæ.

The dorsal part consists of a pair of large, strongly chitinized, lateral arms (Plate 2, fig. 12, *la*) and a cordiform central plate (fig. 13). The lateral arms are extended dorsad, and each is provided on its extremity with a group of strong muscles which ends on the dorsal wall of the head, differing from that of *Forcipomyia*, sensu stricto in which the muscles end on the lateral

wall of the head. The ventral end of this arm is firmly and directly connected with the dorsolateral margin of the central plate. These paired endoskeletons are named by Saunders "the winglike sclerites" in the case of *Forcipomyia*, but in the present larva they are merely rod-shaped and not expanded winglike. Although the homology of these conspicuous skeletons has not been discussed by any of the previous investigators, they are probably related to the pharyngea-lingulæ which are laterally extended from the hypopharyngeal center in the Chironominæ in general.

The central plate is distinctly convex ventrad, forming a large cavity on the dorscal side, and shows a somewhat V-shaped cross section. The margin of this plate is thickened, especially on the cephalic half, where it is rounded, and directly connected with membrane of the epigusta. On the ventral surface of this plate there is a distinct V-shaped transverse ridge, in addition to three pairs of small lateral ridges for the grinding of food and a distinct conical tubercle on the cephalic triangular thickened area. The entire ventral surface is sculptured with minute brown dotlike tubercles. On the dorsal or ental surface there is a V-shaped rig for the reënforcement of this plate, and this ental rib is shown as a dark shadow in the ventral aspect. From the caudal margin of this plate a thin narrow plate of chitin extends caudad along its margin; on the dorsal side of this delicate hyaline plate the first row of fine striation is found, and from the caudal margin of this hyaline plate the second row of striation extends onto the delicate œsophageal membrane. These structures have been regarded as the fringe of hairs before the studies of *Forcipomyia* by Saunders. Along the cephalic margin of this cordiform plate Saunders stated that there is a delicate transverse thickened bridge in *Forcipomyia* and *Apelma*, but such a bridge was not observed in the present case.

The ventral plate (Plate 2, fig. 10) mainly consists of a large median plate and accessory paired rods. The median plate is concave on the dorsal surface corresponding to the convex dorsal plate and semicircular in shape in the dorsal aspect. The dorsal concave grinding surface is studded with numerous minute tubercules but without distinct ridges or teeth, and the lateral and cephalic margins are very strongly thickened. The caudal region is comparatively thin and on the ventral ental surface there is a transverse row of thickened tubercles, and between this row of tubercles and the wall of the œsophagus there is a

thin hyaline transverse plate of chitin from which a row of delicate striæ extends caudad onto the œsophageal membrane as in the caudal margin of the dorsomedian plate. The median plate of the ventral part is reënforced by a strong rib which is across its convex ventral surface. On the laterocaudal corners of the median plate a pair of strong tendons is found from which paired muscles extend to the lateral side of the lateral arms of the dorsal part. From the lateral margin of the median plate a pair of strong rodlike endoskeletons (*vr*) extends cephaloventrad and on each end a strong muscle which ends on the ventral wall of the head is attached. In front of the thickened cephalic margin of the ventromedian plate there is a thin cuticular sclerite (*sl*), which is supported by a pair of rods extending from the laterocephalic margin of the median plate. This thin sclerite is continuous with the membrane that connects the dorsal base of the labial plate and maxillæ and may have originated from the salivia. The long common salivary duct (*sd*) extends beneath the ventromedian plate, is distinctly swollen before the aperture on the dorsal side of the thickened ventral rods (*vr*), and opens into the oval salivos between the dorsal margin of the median plate and the thin salivary sclerite (*sl*).

In addition to these structures of the hypopharyngeal sclerites there is an accessory sclerotization (Plate 2, fig. 10, *a–c*) which is named "the lateral rod-system" by Saunders. This internal sclerotization is developed between the ventromedian plate of the hypopharynx and the marginal chitinization of the mouth aperture and consists of three skeletons, the cephalic pair (*a*) of which is strongest but shortest and arises from the highly chitinized marginal portions of the mouth aperture found caudad of the mentum and extended caudad. From the end of this pair two pairs of long (*b*) and short (*c*) slender rods extend caudad and connect with the lateral margins of the median plate. Of these two rods the long dorsal one (*b*) ends on the caudal corners of the median plate, while the short ventral one (*c*) extends obliquely and ends at the base of the ventral rod (*vr*) of the median plate.

THORAX AND ABDOMEN

The body is slender, composed of the usual three thoracic and nine abdominal segments, and all are slightly depressed dorsoventrally but in alcoholic specimens become swollen cylindrically. The setæ are all slender, small, simple, ordinary in structure and specially finned; bladelike hairs and setiger-

ous tubercles are wanting. Very rarely an aberrant seta (Plate 1, fig. *a*) is found on the dorsum of the first abdominal segment.

The chætotaxy of this larva is distinctly different from that of the *Apelma* group stated by Saunders in reference to that of *F. bromelicola* in the absence of the lateral large setæ and rather similar to that of *F. comis* studied by Mayer excepting the finned hairs.

On each thoracic segment (Plate 1, fig. 6) seven pairs of setæ are shown of which the setæ *a, d,* and *g* are long and simple, while the remaining, *b, e,* and *i,* are small and grow on their independent fleshy minute papillæ. Besides these setæ the thoracic segment is provided with characteristic paired setigerous papillæ (Plate 1, fig. 6, *l,* and fig. *l*) on the venter at the invagination of the leg rudiments. On the prothoracic segment the setæ *d* and *g* are rather shorter and the setigerous papillæ *l* are far better developed than in the other thoracic segments. The seta *i* is often greatly reduced and sometimes wanting.

On the abdominal segments from the first to seventh (Plate 1, fig. 7) typically three pairs of setæ are found on the dorsum, two on the latus, and five pairs on the venter. Of these setæ, *a* and *j* are large and normal, while the others are all tuberculated at the base. On each dorsum of the first, second, seventh, and eighth abdominal segments *a* is very large and *b* is very small, while on the other segments, the third, fourth, fifth, and sixth, *a* becomes small and *b* larger than *a*. On the eighth abdominal segment (fig. 8) the setæ are greatly reduced, being represented only by one pair (*a*) on the dorsum, a tuberculated small seta *f* on the latus, and two tuberculated pairs, *g* and *i,* and one long ordinary pair, *j,* on the venter. On the ultimate ninth segment the arrangement of setæ is somewhat different from that of the preceding segments. The two pairs found on the dorsum are subequal to those of the other segments in their arrangement but the setæ in the position *a* are distinctly smaller than in the other segments. On the latus four setæ are present in the positions *d, e, f,* and near *f,* of which a seta found in the position *e* is tuberculated at the base. On the venter two pairs of setæ are present, of which the two setæ in position *h* are normal in structure, while the two in position *j* are tuberculated at the base.

On the caudal margin of the eighth abdominal dorsum there are two strong simple setæ (Plate 3, fig. 18). These setæ are

not so long as in *F. edwardsi* and *F. bromelicola,* but subequal in proportional length to the setæ in *F. comis,* being slightly shorter than the ultimate segment itself. These two setæ extend parallel and caudad in life, but dorsad in alcoholic specimens; they are very closely situated on a common tubercle, thus differing from the condition in *F. comis.* The basal tubercle is composed of a caudal oval chitinized plate and membranous cephalic sides.

The prothoracic pseudopod exhibits characteristic structures for the *Apelma* group, differing from that of any other related group of *Forcipomyia.* This pseudopod is not divided, forms a conical fleshy protrusion directed ventrocephalad, and is crowned with many slender, curved, hairlike hooklets (Plate 2, fig. 14). These slender hooklets are separated by a bare longitudinal area into two lateral groups and all the hooklets of each group are directed laterad, as clearly shown in a figure given by Saunders. Just behind these groups of hooklets there are one small mesal and three large lateral thornlike hooks (fig. 15) on each side of the median line. These hooks are yellowish, flattened, serrated on one side, and arranged in an oblique line. In number and arrangement these hooks are somewhat different from those of other, related species. On the ventral surface of the remaining proximal area this pseudopod is marked with many transverse rows of minute spines on ridges.

The caudal extremity of the body (Plate 3, fig. 17) is surrounded by fine rugulous ridges bearing minute spines and provided with thornlike hooks on its periphery, a well-developed cauda (*cd*) on its middorsal margin, two pairs of anal gills (*ag*), and a tuberculated ventral projection (*tb*).

The protrusible posterior pseudopods are completely atrophied, and the thornlike hooks are directly studded on the end of the body on either side of the median line. These hooks are golden brown, somewhat flattened, variously serrated on one side, nine on each side, and arranged in two rows. The hooks are conveniently grouped into five types (*a–e*). The dorsal three (*a*) are serrated into small teeth, not sharply pointed, and sometimes provided with dorsal teeth; the lateral two (*b*) on the inner or caudal row are slender, sharply pointed, and very finely serrated; the lateral two (*c*) on the outer or cephalic row are broad, irregularly serrated, and sometimes proved with dorsal teeth; the ventral two are very slender and not serrated on the side—of these hooks the ventral one (*e*) is slenderer than the other (*d*) and ends in two sharp tips,

while the other (*d*) is provided with three or more teeth on the dorsal side of the tip.

The term "cauda" was introduced by Saunders (1925) for the median prolongation of the body above the anus. Although it is said that the cauda of the *Apelma* group is short and bluntly conical, in the present case it (*cd*) is well developed and provided with many, small, pale brown projections, and especially on the caudal side these projections are large and more closely arranged. Near the base of the cauda the dorsal side is pubescent with minute comblike spines as shown in Plate 3, fig. 17.

The anal gills (fig. 17, *ag*) are protruded from either side of the anus and deeply bilobated into large gills, and each is again bilobated partially into small projections, so that there are in all eight delicate pointed processes, as in the other *Apelma* larvæ.

The ventral tuberculous projection (fig. 17, *tb*, and fig. 20) consists of about thirty-seven minute, thickened, papilliform tubercles which are closely arranged in an oval area on a blunt, ventral, fleshy projection. Along the cephalic margin of the tuberculous area there is a narrow special area composed of minute membranous papillæ. From the caudal margin of the tuberculous area a pair of brown setigerous belts extends towards the anus in the shape of a U. The membranous area between these setigerous belts is somewhat more pubescent, with very fine spines and provided with four strong, short setæ on the meson and six similar setæ on the ventral margin of the anus, as shown in fig. 17. An isolated strong seta is found along the lateral side of each setigerous belt near the bases of the hooks *d* and *e*. In the related species *F. comis* this tuberculous projection consists of paired tuberculous patches bearing minute hooklets.

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ILLUSTRATIONS

[Drawings by M. Tokunaga.]

PLATE 1. FORCIPOMYIA CRINUME (TOKUNAGA)

FIG. 1. Genital sheath of male pupa, ventral aspect.
2. Genital sheath of male pupa, lateral aspect.
3. Sinistral prothoracic respiratory horn of female pupa, caudal aspect.
4. Sinistral prothoracic respiratory horn of female pupa, mesal aspect.
5. Sixth abdominal segment of female pupa, sinistral half, caudal aspect; *a–f*, setigerous tubercles; *g*, and *h*, sensory pits; *s*, rudimental spiracle.
6. Larval chætotaxy, thoracic segment. Sinistral square: dorsum; dextral square: venter; median square: lateral fold; *l:* setigerous papilla on the rudiment of leg; *s:* rudimental spiracle; circle by dotted line: prothoracic pseudopod.
7. Larval chætotaxy, typical abdominal segment.
8. Larval chætotaxy, eighth abdominal segment; *a–k*, setæ.
a. Aberrant seta of larva.
l. Setigerous papilla found on rudiment of thoracic leg.

PLATE 2. FORCIPOMYIA CRINUME (TOKUNAGA)

FIG. 9. Head-capsule of full-grown larva, dorsal aspect; *a–j*, ten pairs of setæ; *k–m*, minute sensory setæ; *n–p*, sensory pits.
10. Ventral part of hypopharyngeal region of larva, with mentum, membranes omitted, ventral aspect; *a–c*, accessory endoskeletons; *mt*, mentum; *sd*, salivary duct; *sl*, salivary sclerite (salivia); *vr*, ventral rod.
11. Right antenna of full-grown larva, laterodorsal aspect.
12. Dorsal part of hypopharyngeal region of larva, dextral half removed, dorsal aspect; *la*, lateral arm.
13. Dorsomedian plate of hypopharyngeal region of larva, ventral aspect.
14. Slender hairlike hooklet of larval prothoracic pseudopod.
15. Thornlike hooks on one side of larval prothoracic pseudopod.

PLATE 3. FORCIPOMYIA CRINUME (TOKUNAGA)

FIG. 16. Larval mouth parts, dextral maxilla removed, ventral aspect; *ll*, labralia; *lr*, labrum; *md*, mandible; *mx*, maxilla; *pm*, premandible.
17. Caudal end of abdomen, dextral half, full-grown larva, caudal aspect; *a–e*, various thornlike hooks; *ag*, anal gill; *cd*, cauda; *tb*, tuberculous projection.
18. Setigerous tubercle of eighth abdominal dorsum, full-grown larva.
19. Tuberculated hair of larval head capsule.
20. Tuberculous projection, ventral aspect.

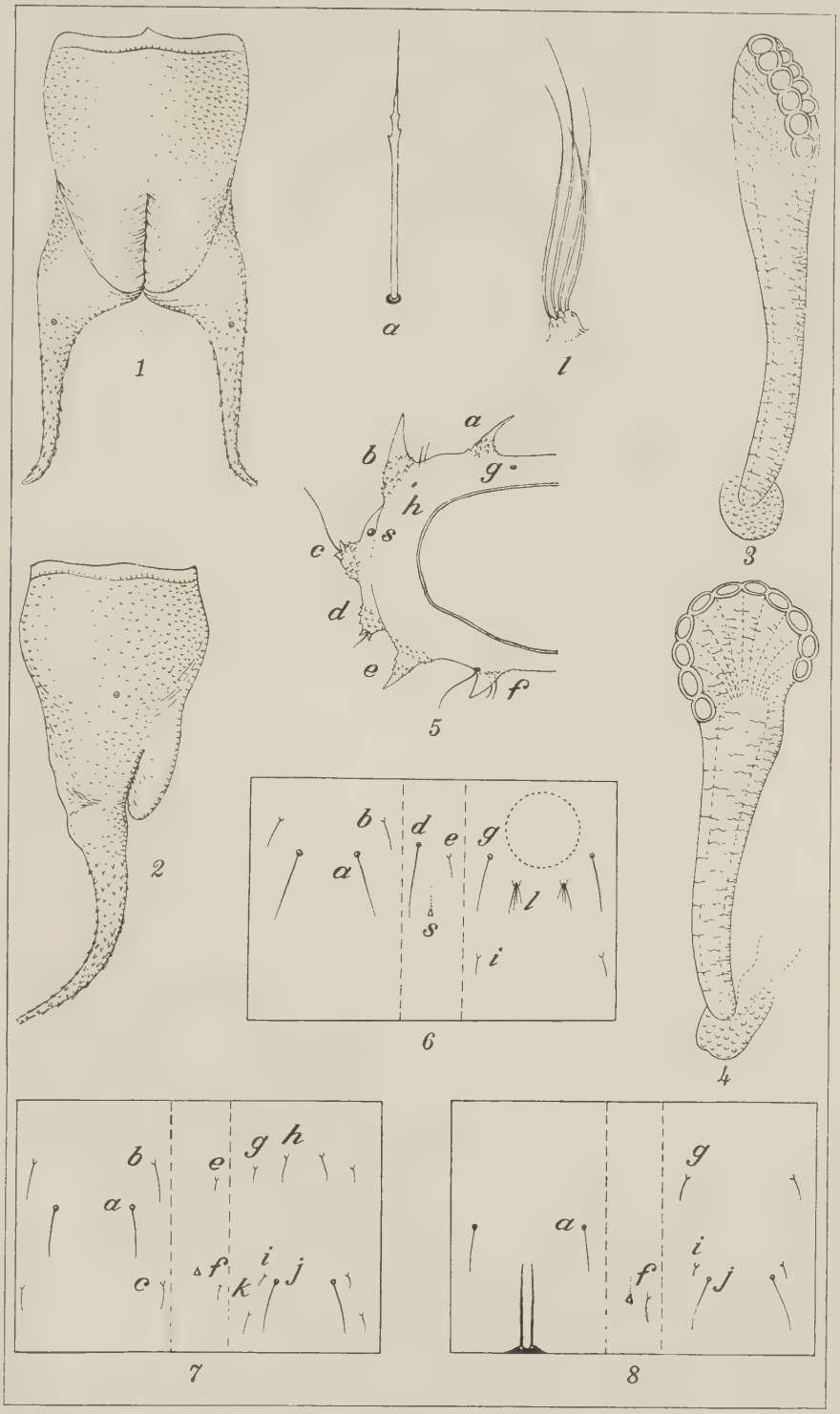

PLATE 1.

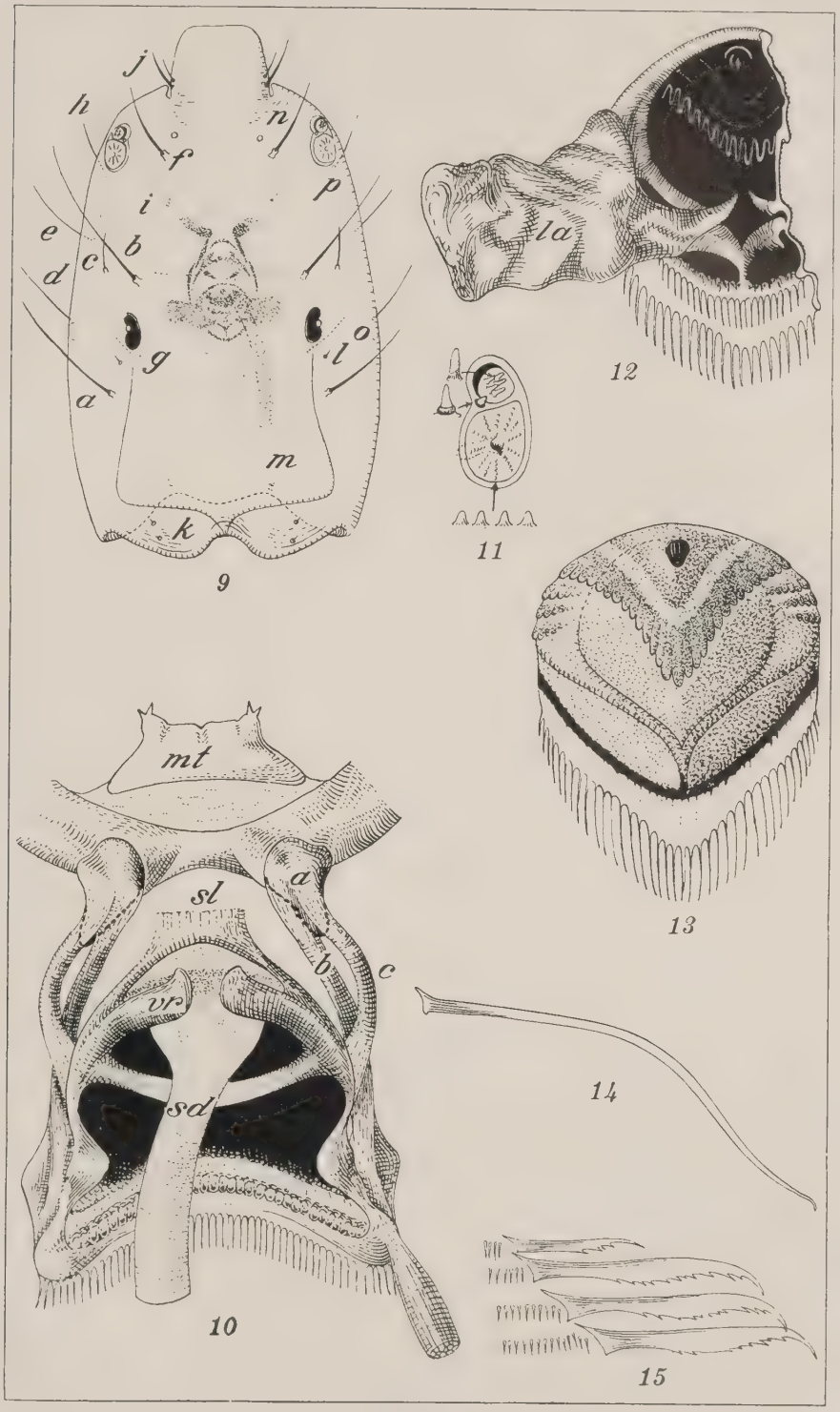

PLATE 2.

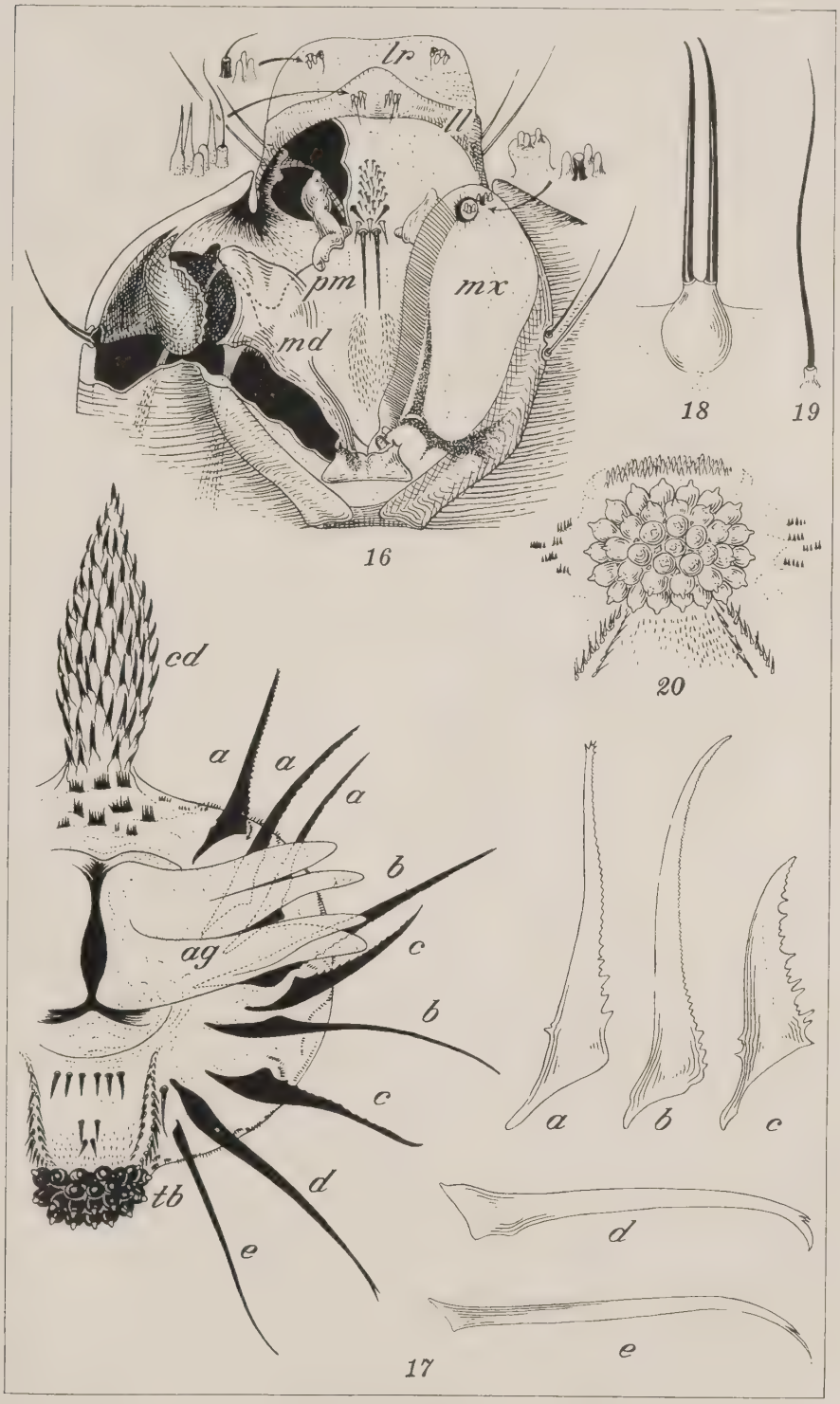

PLATE 3.

THE COMPOSITION OF PHILIPPINE WOODS, VI [1]

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and

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FOUR PLATES

This paper is a continuation of our work on the composition of Philippine (tropical) woods and makes the sixth report in this series of publications.[2] The composition of woods is a matter of considerable importance for industries that use wood as their basic raw material. An account of the general properties of the woods recorded in this paper is given by Schneider.[3] Brief descriptions are as follows:

Apitong (*Dipterocarpus grandiflorus* Blanco) is one of the important members of its genus. This genus belongs to the dipterocarp, or lauan, family which is by far the most prominent family of trees in the Philippines. The dipterocarp forests cover about 75 per cent of the virgin forest area (30,000 square miles) of the Philippines and contain approximately 95 per cent of the total amount of standing timber in the Islands. They are found on nearly all types of topography.

These woods are everywhere utilized for a wider range of uses than those of any other family. The most characteristic feature of these trees is that they contain resin ducts. When the bark and sapwood are cut the oily resin exudes more or less freely and, on exposure to the air, the resin hardens into a sticky, pasty mass.

Apitong, like most other dipterocarps, is a large tree which reaches a diameter of 100 to 150 centimeters and a height of 40

[1] This work is carried on coöperatively by the division of chemical research, Bureau of Science, and the Bureau of Forestry.

[2] Yenko, F. M., Luz Baens, A. P. West, and H. M. Curran, Philip. Journ. Sci. 47 (1932) 281 and 343; 48 (1932) 299; 49 (1932) 587; 52 (1933) 209.

[3] Bull. P. I. Bur. Forestry 14 (1916).

to 50 meters. It usually has a straight, regular bole. According to Schneider the wood of all species of dipterocarps is practically identical as far as structure goes; in weight, hardness, and color the differences between various species seem to be no greater than those found between individuals of the same species growing in different regions. All are classified as apitong in commerce.

Like other dipterocarps the wood of apitong is moderately hard to hard, stiff and strong, and moderately heavy to heavy. The texture is rather coarse and the wood has a resin odor when fresh. If not seasoned carefully the wood is liable to warp. It has a durability of 3 and it is not commonly attacked by beetles, though occasionally by dry rot. The wood is used for cheap and medium-grade furniture and for general construction work.

Gatasan (*Garcinia venulosa* Choisy) is a tree which reaches a diameter of 40 centimeters. It has hard wood that is heavy to very heavy and generally yellow in color, though some specimens are red. The grain is straight and the texture fine, dense, and glossy. This wood seasons without warping, but is liable to split. Although it does not saw easily it is not otherwise difficult to work. The durability is about 2 and it is not attacked by beetles. It is used for general construction work. The red variety has an excellent reputation for posts.

The particular oak wood analyzed for this report was Bennett's oak, or pangnan (*Quercus bennettii* Miquel). Oak trees generally grow in the mountainous regions of the Philippines. Some are tall trees, reaching diameters of 40 to 100 centimeters. The wood is usually moderately hard to hard and heavy to very heavy. The texture is fine and dense in most specimens, though somewhat porous in others. It has a durability of about 3 and is not attacked by beetles. It seasons well if carefully stacked and may be used for all kinds of construction work.

Camagon (*Diospyros discolor* Willdenow) is the largest and best known tree of its genus. It ordinarily grows to a diameter of 60 centimeters or more. The relative amounts of sapwood and heartwood vary considerably in different specimens, and the color of the sapwood varies from pinkish to pale red. The wood is hard, heavy, and has a high specific gravity. The grain is generally very straight and the texture fine and very dense in the heartwood. It is difficult to season and to work, but takes a beautiful surface under sharp tools. The heartwood has a durability of 1 and the sapwood 2. The wood is used for numerous

purposes and is especially suitable for musical instruments, cabinetwork, and furniture.

Tanglin (*Adenanthera intermedia* Merrill) is a tree that grows to a diameter of 70 centimeters. The wood is hard and heavy. The texture is fairly fine and glossy and resembles that of ipil. The wood seasons well and has a durability of 2. It is used for general construction work.

Tináan-pantai (*Cyclostemon bordenii* Merrill) grows to a diameter of 95 centimeters. The wood is hard and heavy. The grain is very straight and the texture fine and dense. If sawn when fresh and carefully stacked, it seasons with little staining and checking. Although a hard wood, it is not difficult to saw and is easy to shape and surface. The durability is 3, and it is not attacked by beetles. This wood is especially useful for all sorts of interior work.

Amugis (*Koordersiodendron pinnatum* Merrill) is a tall straight tree that may reach a diameter of 100 centimeters. The wood is hard and heavy and the texture fine. The durability is 3, and it is rarely attacked by insects. It may be used for furniture, cabinetwork, and general construction.

Narig (*Vatica mangachapoi* Blanco) is a tall slender tree that may reach a diameter of 70 centimeters. The wood is hard and heavy. The texture is very fine and dense, with a fine, straight grain. It seasons well and is fairly easy to surface. It has a durability of 1 and is used for permanent construction.

Tuai (*Bischofia javanica* Blanco) is a tall straight tree that sometimes grows to a diameter of 150 centimeters. The wood is moderately hard and heavy. The color of the sapwood varies from light cream to reddish brown. The heartwood is dark reddish brown with a purplish tinge. The texture is coarse. This wood checks and warps badly if not seasoned very carefully, but is fairly easy to work. The durability is about 3. It is used for various purposes, such as posts, beams, and foundation piling.

Kalukoi (*Ficus malunuensis* Warburg) is a medium-sized tree. It is found at low to medium altitudes, scattered in the open as well as in the forest, and grows to a diameter of 60 centimeters. The bole is straight and heavily buttressed. The bark is rather white, but when cut, the color varies from yellow to orange and the bark exudes a watery sap.

Kalumpit (*Terminalia edulis* Blanco) grows to a diameter of 60 centimeters or more. It is a tall straight tree. The wood

is moderately hard and heavy. The texture resembles that of talisay but is somewhat finer and glossier. This wood has a durability of 3 and imparts a yellow color to water. It is used for beams, joists, posts, and for furniture and cabinetwork.

Tamayuan (*Strombosia philippinensis* Rolfe) grows to a diameter of 50 centimeters. The wood, though brittle, is hard and heavy. It has a very fine, dense, and smooth texture. It seasons with little warping, is easy to work, and takes a smooth, silky surface under a sharp plane. The durability is 2. It is used for piles, posts, beams, mine timbers, tool handles, furniture, and cabinetwork.

In Table 1 are given the measurements of the trees from which samples were taken for our analyses.

TABLE 1.—*Measurements of Philippine trees used for wood analysis.*

Name of tree.	Diameter.	Total height.	Clear length of trunk.	Height from which specimen was taken.	Specific gravity of wood.
	cm.	*m.*	*m.*	*m.*	
Apitong; [a] *Dipterocarpus grandiflorus*	----------	----------	----------	----------	----------
Gatasan; *Garcinia venulosa*	30.0	16.0	5.7	2.00	0.886
Oak; *Quercus bennettii*	----------	21.8	6.0	----------	0.959
Camagon; *Diospyros discolor*	----------	22.9	6.4	----------	1.218
Tanglin; *Adenanthera intermedia*	26.0	16.0	6.0	----------	1.057
Tinaan-pantai; *Cyclostemon bordenii*	29.0	18.6	8.0	----------	0.946
Amugis; *Koordersiodendron pinnatum*	21.0	20.0	9.0	1.68	0.800
Narig; [a] *Vatica mangachapoi*	----------	----------	----------	----------	----------
Tuai; *Bischofia javanica*	44.0	----------	11.5	----------	0.810
Kalukoi; *Ficus malunuensis*	21.3	14.5	5.4	0.75	0.448
Kalumpit; *Terminalia edulis*	42.0	21.0	12.0	2.64	0.598
Tamayuan; *Strombosia philippinensis*	26.0	16.0	6.0	----------	1.09

[a] These trees were of average mature size. The measurement records were lost.

In analyzing the wood samples we followed, in general, the methods adopted by the forest-products laboratory at Madison, Wisconsin.[4] We introduced certain details in the analytical procedure [5] because we found by previous experience that this increased the accuracy of the results.

The results of analyzing the woods recorded in this paper are given in Table 2.

[4] Bray, M. W., Paper Trade Journ. 87 No. 25 (1928) 59. Schorger, A. W., Chemistry of Cellulose and Wood (1926) 505.

[5] Yenko, F. M., Luz Baens, A. P. West, and H. M. Curran, Philip. Journ. Sci. 47 (1932) 343.

TABLE 2.—*Analysis of Philippine woods.*

[The percentages were calculated on a moisture-free basis.]

Constituent.	Apitong; *Dipterocarpus grandiflorus.*	Gatasan; *Garcinia venulosa.*	Oak; *Quercus bennettii.*	Camagon; *Diospyros discolor.*	Tanglin; *Adenanthera intermedia.*	Tinaanpantai; *Cyclostemon bordenii.*
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Cold-water soluble	1.61	4.57	4.32	4.56	4.82	4.51
Hot-water soluble	5.07	8.28	6.97	8.12	7.16	5.70
Alkali soluble	16.12	21.60	15.86	21.12	17.44	16.05
Ether extract	1.38	4.77	0.29	1.35	1.97	0.71
Alcohol extract	2.61	6.76	3.96	6.35	5.76	3.29
Ash	0.99	1.45	0.33	1.33	0.82	1.66
Nitrogen	0.53	0.32	0.36	0.29	0.19	0.37
Lignin	35.19	34.84	34.67	33.66	34.91	31.61
Cellulose	47.60	50.97	57.32	49.12	52.43	52.77
Ash in cellulose determined.	0.55	0.04	1.32	0.49	0.28	0.30
Cellulose ash free	47.05	50.93	56.00	48.63	52.15	52.47
Alpha cellulose in total cellulose.	74.13	73.68	71.31	70.79	76.38	79.70
Alpha cellulose in the wood.	35.29	37.55	40.87	34.77	40.05	42.06

Constituent.	Amugis; *Koordersiodendron pinnatum.*	Narig; *Vatica mangachapoi.*	Tuai; *Bischofia javanica.*	Kalukoi; *Ficus malunuensis.*	Kalumpit; *Terminalia edulis.*	Tamayuan; *Strombosia philippinensis.*
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Cold-water soluble	0.82	4.75	1.71	3.18	4.53	1.33
Hot-water soluble	2.41	7.13	3.38	4.93	8.30	2.92
Alkali soluble	18.43	23.53	28.94	13.05	19.86	11.87
Ether extract	0.95	1.76	0.47	0.62	0.41	0.78
Alcohol extract	1.97	6.66	0.36	2.85	5.31	1.70
Ash	1.07	0.48	1.53	3.03	0.41	0.57
Nitrogen	0.28	0.27	0.30	0.53	0.25	0.41
Lignin	33.76	30.40	48.00	30.00	33.51	36.56
Cellulose	51.65	53.19	41.53	56.13	51.26	50.65
Ash in cellulose determined.	0.23	0.22	0.30	0.43	0.13	0.29
Cellulose ash free	51.42	52.97	41.23	55.70	51.13	50.36
Alpha cellulose in total cellulose.	76.75	74.12	72.92	77.19	70.75	81.69
Alpha cellulose in the wood.	39.64	39.42	30.28	43.33	36.27	41.38

SUMMARY

Twelve samples of Philippine woods were analyzed in this investigation. These woods have the common names apitong,

gatasan, oak, camagon, tanglin, tinaan-pantai, amugis, narig, tuai, kalukoi, kalumpit, and tamayuan.

As shown by the data (Table 2) tuai wood had the highest content of lignin (48 per cent). Oak wood had the highest cellulose (57.32 per cent). The wood that contained the highest percentage of alpha cellulose was kalukoi (43.33 per cent). Cellulose obtained from the tamayuan wood had the highest content of alpha cellulose (81.69 per cent).

ILLUSTRATIONS

Plate 1

Fig. 1. Apitong; *Dipterocarpus grandiflorus* Blanco.
2. Gatasan; *Garcinia venulosa* Choisy.
3. Oak; *Quercus bennettii* Miquel.

Plate 2

Fig. 1. Camagon; *Diospyros discolor* Willdenow.
2. Tanglin; *Adenanthera intermedia* Merrill.
3. Tinaan-pantai; *Cyclostemon bordenii* Merrill.

Plate 3

Fig. 1. Amugis; *Koordersiodendron pinnatum* Merrill.
2. Tuai; *Bischofia javanica* Blanco.
3. Kalukoi; *Ficus malunuensis* Warburg.

Plate 4

Fig. 1. Kalumpit; *Terminalia edulis* Blanco.
2. Tamayuan; *Strombosia philippinensis* Rolfe.

PLATE 1.

PLATE 2.

PLATE 3.

PLATE 4.

AN AUTOMATIC DISTRIBUTING MACHINE FOR PARIS GREEN MIXTURES[1]

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TWO PLATES AND TWO TEXT FIGURES

Malaria in the Philippines is carried by stream-breeding anophelines and, at present, there are no other known vectors. Swamps, rice fields, ponds, salt-water pools and lagoons, although prolific sources of anophelines of several species, do not appear to menace the health of nearby communities. The problem of malaria prophylaxis, so far as larvicidal measures are concerned, is limited to the control of streams. The classical picture of marsh-fever is not seen. Not the lowlands, but the well-drained foothill areas, are malarious.(1, 2)

Paris green, applied to streams, although not widely used in the Philippines, has successfully controlled malaria in several places throughout the Archipelago. The most notable success has been that at Fort Stotsenburg.(3, 4, 5) There seems to be little doubt that this larvicide can be used effectively here as elsewhere. But, as in all tropical areas, the cost of malaria control in the Philippines is more than most communities can bear. This is true despite the fact that Tiedeman(6) succeeded in controlling malaria at a cost of only 30 cents United States currency per capita per year.

It costs approximately 183 dollars per 10,000 meters of stream bank per year in this country to control anopheline breeding by the use of Paris green. Of this amount, approximately 52

[1] This machine was designed and built at the College of Engineering, University of the Philippines, at the suggestion of Malaria Investigations of the Bureau of Science. Malaria Investigations is jointly supported by the bureau and by the International Health Division of the Rockefeller Foundation. The authors make grateful acknowledgment of the assistance of Dean Hyde, of the College of Engineering.

dollars represents the cost of materials and 131 dollars the cost of labor. Moreover, as elsewhere in the Tropics, the labor is not always satisfactory as regards the intelligent or even faithful application of the larvicidal mixture. Therefore, to the above costs must be added those of supervision. It appears that cost of labor and, above all, the expensiveness of supervision, have been real barriers to practical malaria control in the Philippines, except in a few populous places. In many areas not only in the Philippines but elsewhere in the Far East, a per capita expenditure of more than 5 cents United States currency per annum for malaria prophylaxis is not feasible.

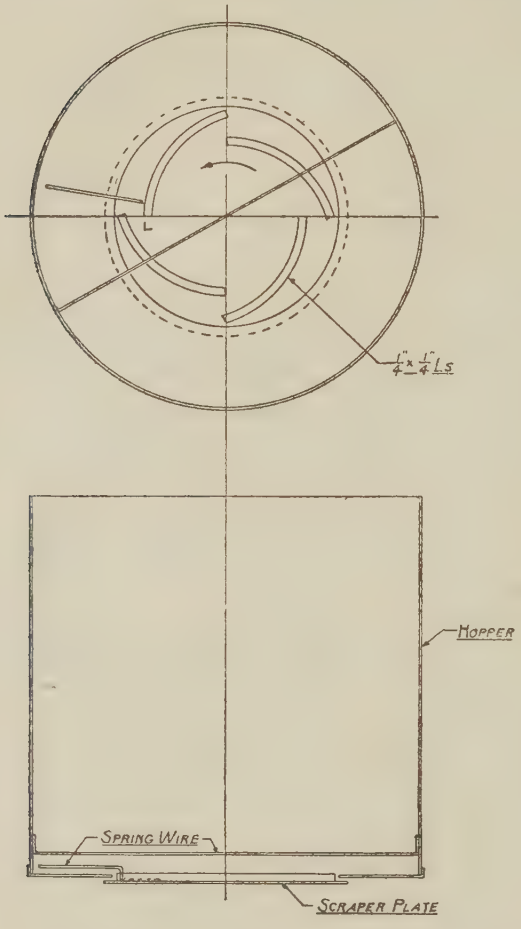

FIG. 1. Automatic distributor of Paris-green mixtures. Diagrammatic cross section of hopper. L represents section of angle iron in elevation. Ls, angle irons. Scale, approximately, 1/6 of full size.

Economically malaria prophylaxis is essentially a matter of time and money. If money is available in large amounts malaria prophylaxis can be accomplished in a relatively short time. If, on the other hand, a small annual appropriation is used intelligently and continuously it will in time reduce the malaria rate to a reasonable figure.

For some years we have been experimenting with various devices in an attempt to make possible the automatic distribution of Paris green in streams. Such a machine, if effective, would materially reduce the cost of control and would also make more certain the application of the larvicidal dust. A simple gravity distributor has already been reported by one of us.(7) The present paper gives

details of a machine which is motivated by the stream over which it is placed. It is an improvement over the gravity device because it will distribute the usual finely powdered mixtures, whereas the first machine required a heavier, sand mixture to avoid clogging. This second machine may also be weight-driven, as will be reported later.

DESCRIPTION

This power-driven powder distributor is made of galvanized metal sheeting, iron castings, and a steel rod. The hopper is 1 foot high with a diameter also of 1 foot. The paddle is 1 foot high and 13 inches in diameter. The most important parts are the hopper, the revolving plate, and the paddle wheel. The latter is of the S-rotor type. The capacity of the machine is 20 liters and it empties in twenty-four hours at average speed. The time of emptying will depend, of course, on the speed at which the plate turns and on the size of the opening, which is adjustable.

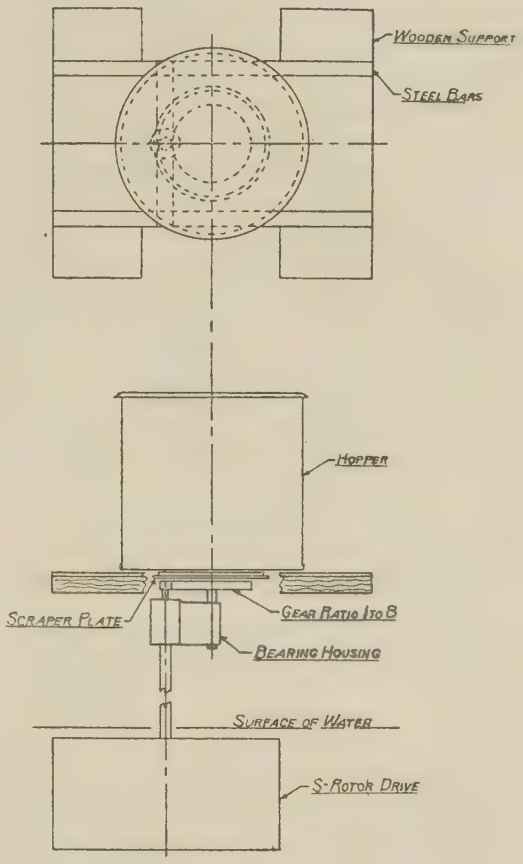

FIG. 2. Automatic water-driven distributor of Paris-green mixtures. Diagrammatic. Scale 1/12 of full size.

The Paris-green mixture falls from the machine to the stream and is distributed by the currents of water. As noted in the first paper(7) the eddies and whirlpools of the stream give a fairly good distribution so that the larvicide is effective for several hundred meters. Naturally, not all streams could be treated in this way and in some cases not all the larvæ will be killed. But it is possible in many streams so to reduce the incidence of larvæ that there will be less than the

critical number of adult mosquitoes necessary to the propagation of malaria. Ross(8) showed that it is not essential to destroy literally every malaria-carrying mosquito to control malaria. Complete eradication, although sometimes feasible, is usually too costly a procedure. It is a week by week, continuous attack on the larvæ that is most important. Where time is abundant and money scarce it is not possible to use the most efficient method. One must choose between no control at all or such modest measures as may in time produce the desired results.

These machines can be built locally for three dollars United States currency each. Therefore, several may be used in the same stream, located at strategic points. Baffle boards may be used in the stream just below the machine to direct the floating larvicide to the edges.

Any of the usual dust mixtures may be used. We prefer powdered charcoal because of its cheapness locally and its floating properties. The outlet of the machine is adjustable so that the volume of flow may be regulated to the needs. In some places it may be necessary to increase the percentage of Paris green from the usual 1 to 99 proportion. Each stream will require special study, but once the machines are erected the labor factor becomes greatly reduced.

Other possibilities suggest themselves. For example, possibly wind-driven distributors could be used in some areas. The type of distributor presented in this paper could be adapted for either a weight or a wind drive at a slightly greater cost.

SUMMARY

This paper presents an automatic distributing machine for Paris-green mixtures. This powder distributor is motivated by the current of the stream in which the larvicide is to be distributed. It is a low-priced and effective mechanism, which in some places will materially reduce the cost of malaria prophylaxis.

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ILLUSTRATIONS

PLATE 1

FIG. 1. Automatic distributor of Paris-green mixtures. Paddle wheel.
2. Automatic distributor of Paris-green mixtures. Inside of hopper.
3. Automatic distributor of Paris-green mixtures. Gears and supports.

PLATE 2

FIG. 1. Automatic distributor of Paris-green mixtures. Machine in place over a stream.
2. Automatic distributor of Paris-green mixtures. Machine in place over a stream. Near view.

TEXT FIGURES

FIG. 1. Automatic distributor of Paris-green mixtures. Diagrammatic cross section of hopper. L represents section of angle iron in elevation. *Ls*, angle irons. Scale, approximately, 1/6 of full size.
2. Automatic water-driven distributor of Paris-green mixtures. Diagrammatic. Scale 1/12 of full size.

PLATE 1.

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PLATE 2.

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[New names and new combinations are printed in boldface.]

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